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IN THIS ISSUE

IN SURVEYS of the nutritional health of population groups, diet records and values on blood content of nutrients have been employed extensively as measures of the nutritional status of persons studied. The association between the diet and blood values for individuals has been found to be low and sometimes it is not statistically significant. An analysis of the relationship between reported diet intake of ascorbic acid and plasma ascorbic acid values for several different population groups is presented in the article "The Statistical Association Between the Diet Record of Ascorbic Acid Intake and the Blood Content of the Vitamin in Surveyed Populations" by Persis Putnam, D. F. Milam, R. K. Anderson, W. J. Darby, and P. A. Mead. For the different population groups, wide differences in the correlation between diet intake and plasma content are reported and the average plasma level is not constant for a specific average intake. Of special interest to research workers in this field is the discussion of a method of statistical analysis of association which is applicable to many studies of the relationship between nutrient intake and biochemical levels.

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A paper in this issue, "Demographic Characteristics of Women in WHO'S WHO," by Clyde V. Kiser and Nathalie L. Schacter, is based upon data afforded in the printed sketches of virtually all women in the 1948–1949 edition of WHO'S WHO IN AMERICA. It relates to occupation or field of distinction, place of residence, place of birth, educational attainment, age, marital status, age at marriage, religion, and fertility of these women. The high proportion of WHO'S WHO women that are unmarried, the high proportion of the ever-married reporting

no children, and the low proportion reporting more than two children serve to emphasize that in our culture the conflict between, or at least the incompatibility of, career and marriage and children is still strikingly more pronounced among women than among men.

THE STATISTICAL ASSOCIATION BETWEEN THE DIET RECORD OF ASCORBIC ACID INTAKE AND THE BLOOD CONTENT OF THE VITAMIN IN SURVEYED POPULATIONS[1]

PERSIS PUTNAM, D. F. MILAM, R. K. ANDERSON, W. J. DARBY AND P. A. MEAD

I. A STATISTICAL RECONNAISSANCE

INTRODUCTION

EARLY in 1939 the International Health Division of The Rockefeller Foundation entered the field of nutrition with a grant to the Vanderbilt University School of Medicine. Later field studies were inaugurated in North Carolina under the auspices of the State Board of Health and Duke University. In 1942 similar studies, also supported by the International Health Division, were undertaken in Mexico under the auspices of the Ministry of Public Health and Welfare.

These field investigations were designed to furnish a picture of the individual's food consumption and of his nutritional and physical status at a given time. One objective was to determine whether a relationship existed between consumption, as derived from the diet record, the biochemical measure of the nutritional status of the individual, and his physical well-being. In other words, would persons in groups with poor diets have a lower average rating in the laboratory examinations and exhibit signs of clinical deficiency with greater frequency than would individuals with more adequate diets? Such an eventuality may be expected only if the diet record affords a reasonably accurate statement of the amount of the nutrient ingested, if the amount ingested during the week of the survey is similar to that customarily consumed, if the laboratory findings do in fact reflect its concentration in the body, and if there exists a

[1] The data analyzed were obtained in surveys made (1) under the auspices of the North Carolina State Board of Health and Duke University, and (2) the Ministry of Public Health and Welfare of Mexico and its subdivisions, with the assistance of the International Health Division of The Rockefeller Foundation.

direct relationship between physical well-being and the quantity of the nutrient consumed.

The frequently observed lack of association between nutritional status and recorded dietary intake has been disappointing to investigators, and attempts have been made to explain the phenomenon. Kruse (1) calls attention to the time element involved in the development of tissue evidence of deficiency states. Blood plasma level of some nutrients may vary from week to week. It may be below normal for some time before tissue lesions appear and may return to normal long before they heal. Nutrition Reviews (2) makes the following comment on the inadequacy of the instantaneous field survey:

> It would appear that there is a fundamental fallacy inherent in the short-term nutrition survey in which dietary history or careful records of food intake, physical examinations, biochemical and microbiologic determinations are carried out in so short a span. . . . The clinical signs which are diagnostic of deficiency disease usually result from protracted deficiencies; the biochemical status at an instant in time is a composite of underlying tissue stores or deficits and the balance between recent losses and recent accruals from intake; and the dietary story is accurate only for the particular time when records are kept.

Dann and Darby (3) define five zones of nutriture: (1) saturation; (2) unsaturated, but functionally unimpaired; (3) potential deficiency disease; (4) latent deficiency disease, and (5) clinically manifest deficiency disease. They comment:

> A deduction frequently made in the past is that for every manifest case of deficiency disease caused by severe dietary deficiency, many persons must consume diets deviating less widely from completeness and therefore be suffering either from mild, or latent, or potential deficiency disease. Many attempts have therefore been made (a) to refine the methods of clinical diagnosis of mild and latent deficiency disease; (b) to devise biochemical or physiological tests which will detect potential deficiency disease. Unfortunately these attempts have met with little success.

Examination of the data collected in the various population surveys in which the International Health Division was associated revealed relatively few individuals with recognizable deficiency states of a serious character. Although intake as measured by the diet record may have been unsatisfactory in many instances, any untoward effect upon the nutriture of the individual lay chiefly within the realm of unsaturation or of potential or latent deficiency disease which cannot be adequately assessed by present-day clinical methods suitable for application in large population groups.

THE PRESENT OBJECTIVE

Dietary, biochemical, and clinical findings have been presented in the published reports of the various field surveys, but no previous report has described an attempt to explore the statistical association between the amount of a nutrient consumed, as given by the diet record, and its level in blood serum or plasma as revealed by the laboratory examination in these surveyed populations. The object of this paper is to report the results obtained from the application of statistical method to the data from these surveys to determine the existence, the amount and the form of such a relationship.

THE INITIAL APPROACH TO THE PROBLEM

A preliminary analysis was made of the data provided by the diet records and the laboratory tests for persons in white families who were included in the surveys of Wayne and Alamance Counties of North Carolina to determine their interrelationships. Data pertaining to persons surveyed in each of the four seasons were kept separate and the population was further subdivided into three age and sex groups, males and females under 15 years of age, males of 15 years and over and females of 15 years and over. There were thus twelve population groups for each county or twenty-four in all.

For each of these twenty-four groups three series of correlation tables were set up. In the first, the results of the laboratory

tests were compared, e.g., the blood content of ascorbic acid with that of vitamin A, vitamin A with carotene, etc. Correlation coefficients for seven pairs of variables were computed. The results will not be reported in detail, but significant correlation was obtained with sufficient frequency to warrant the conclusion that individuals with a satisfactory rating biochemically in respect to one nutrient might be expected to rate well for at least some of the others. An instance of this was the significant correlation found for fourteen of the twenty-four population groups between plasma vitamin C and carotene.

In the second series of correlations a comparison was made between fourteen pairs of nutrients in the food consumed, as given by the diet records. Many of these comparisons yielded significant correlation of a fairly high order. This was to be expected, however, since many foods, e.g., milk or leafy vegetables, are rich in more than one nutrient, and if consumed in large quantities, will raise the intake level of each of their constituents.

The crucial series of correlations, however, was that in which the nutrients in the diet were paired with those in the blood. Here the significant coefficients were few in number. The only comparison giving consistently significant correlation (fifteen of twenty-four population groups) was that between ascorbic acid intake and blood content. This result was not unexpected, for although vitamin C is stored in the body tissues, it must be frequently ingested if the blood levels are to be maintained.

The present analysis will, therefore, attempt to describe the various aspects of this relationship. Means and standard deviations have been computed for the two variables (ascorbic acid in the diet and in the blood) together with the correlation coefficients which indicate the amount of association between them. Chi-square tests have been applied to the data arranged in fourfold tables. Finally, regression equations have been calculated and straight lines plotted to the data for populations grouped on an area basis. The objective has been not only to determine the existence and nature of the relationship but to

show in some detail the steps in the statistical approach to this problem.

SURVEY MATERIAL AND METHODS

The data for Wayne County, North Carolina, used in this analysis were collected in 1942–1943 and pertain to persons in 120 white families from the rural sections of eleven of twelve townships. In the summer of 1943 a similar survey was begun of 160 white families in Alamance County. Procedures and results in respect to dietary intake of nutrients and to clinical manifestations of deficiency have been reported for the surveys in both counties (4 and 5a, b). The 1943–1944 Mexican survey for which data have been analyzed was that of the Otomi Indians, living in four villages in the Mezquital Valley about 75 miles from Mexico City (6).

The diet records of persons included in this study covered a seven-day period from which average daily amounts of calories, and specific nutrients consumed by each person were computed with the use of food tables. The ascorbic acid content of food consumed by persons surveyed in the North Carolina counties was computed for raw foods only because of the belief that the customary prolonged cooking of vegetables destroyed most of the vitamin, while in the Mexican survey no correction was made for cooking losses since the most common foods containing vitamin C were either eaten raw or seldom cooked excessively. The amount of ascorbic acid consumed by the North Carolinians was, therefore, understated while that estimated for the Mexican Indians was perhaps overstated. The Otomi Indians obtained 48 per cent of their ascorbic acid from pulque, the fermented juice of the century plant (from 3 to 5 per cent alcohol), which is consumed in large quantities by persons at all ages but particularly adults.

Standard sources were used in North Carolina in preparing tables for converting food consumed into its component nutrients, but the dietary calculations in Mexico were based largely on the analysis of foods collected locally during the period of the survey (7). For the data collected in Mexico and in Wayne

Table 1. Means of ascorbic acid blood plasma content and of recorded daily food intake, with standard deviations and correlation coefficients for surveyed white population groups in North Carolina.

Population Group	Ascorbic Acid						Ascorbic Acid					
	No. Persons	Plasma (mgm %)		Intake (mgm)		Correl. Coef.	No. Persons	Plasma (mgm %)		Intake (mgm)		Correl. Coef.
		Mean	S. D.	Mean	S. D.			Mean	S. D.	Mean	S. D.	
	Wayne Co. 1942–1943						Alamance Co. 1943–1944					
Summer												
M,F, – 15	35	0.89	0.29	50.6	54.4	+0.592*	40	1.01	0.34	46.0	25.7	+0.738*
M 15 +	23	0.60	0.42	38.0	46.2	+0.365	36	0.68	0.46	46.9	30.1	+0.397*
F 15 +	26	0.54	0.30	23.5	22.6	+0.248	52	0.68	0.37	40.2	23.8	+0.390*
Total	84	0.70	0.42	39.3	45.9	+0.432*	128	0.78	0.42	43.9	26.5	+0.394*
Fall												
M,F – 15	37	0.90	0.38	30.9	28.0	+0.481*	42	1.04	0.48	47.1	28.0	+0.031
M 15 +	28	0.40	0.30	30.4	32.3	+0.028	31	0.52	0.32	31.1	25.5	+0.206
F 15 +	41	0.70	0.36	28.1	21.1	+0.338*	44	0.70	0.32	27.2	17.3	+0.284
Total	106	0.68	0.40	29.8	26.8	+0.267*	117	0.78	0.45	35.6	25.4	+0.246*
Winter												
M,F – 15	49	0.61	0.40	31.9	22.6	+0.180	64	0.72	0.42	43.6	28.7	+0.303*
M 15 +	30	0.41	0.15	24.0	21.7	+0.572*	20	0.34	0.31	47.5	38.1	+0.151
F 15 +	30	0.48	0.30	23.0	18.9	+0.622*	42	0.48	0.31	41.2	33.4	+0.478*
Total	109	0.49	0.37	28.3	21.4	+0.390*	126	0.58	0.40	43.4	32.0	+0.285*
Spring												
M,F – 15	18	0.61	0.40	26.1	26.4	+0.714*	35	0.76	0.35	48.1	28.6	+0.511*
M 15 +	15	0.42	0.46	16.8	11.8	+0.449	34	0.31	0.25	40.6	23.7	+0.451*
F 15 +	31	0.35	0.36	19.8	16.0	+0.371*	51	0.52	0.41	43.2	23.4	+0.471*
Total	64	0.44	0.41	21.9	17.9	+0.521*	120	0.53	0.39	43.9	25.3	+0.466*
Grand Total												
M,F – 15	139	0.76	0.40	35.4	35.6	+0.426*	181	0.87	0.43	45.8	27.9	+0.279*
M 15 +	96	0.43	0.37	28.1	32.1	+0.310*	121	0.48	0.39	41.2	29.6	+0.276*
F 15 +	128	0.53	0.37	23.7	20.0	+0.404*	189	0.59	0.37	38.2	25.7	+0.336*
Total	363	0.59	0.41	30.2	30.4	+0.395*	491	0.66	0.43	41.7	27.7	+0.416*

* $P < 0.05$.

County each food was evaluated separately, but certain similar foods were grouped in the tables used for Alamance County and an average value was assigned to each of the nutrients contained in the foods of the group.

Ascorbic acid in the blood was determined by the macromethod described by Mindlin and Butler (8). In North Carolina the determinations were based on plasma, in Mexico on serum. Here reference should be made to the discussion by Wiehl and Kantorovitz (9) of the errors in the photelometric method of determining ascorbic acid in the plasma. These authors obtained a standard deviation of approximately 0.04 mgm per cent for estimates of the plasma content when the amount of ascorbic acid in the standard employed was 1.5 mgm per cent when K of the formula was computed. In North Carolina and Mexico an average value for K was computed daily from the results obtained from three concentrations of the standard, 1.0, 1.5 and 2.0 mgm per cent.

Records included in this study pertain to individuals with data on both dietary intake and blood examination. Because of this requirement records of children under two years of age have been omitted. Records of pregnant and lactating women are included, although it has been shown (10) that the blood content of ascorbic acid of such persons is reduced. Consequently the members of the various groups may not be strictly homogeneous in respect to intake necessary to maintain a given blood content.

STATISTICAL ATTRIBUTES OF THE POPULATION GROUPS

North Carolina. Table 1 contains the statistics pertaining to ascorbic acid intake and plasma content for each of the twenty-four population groups in Wayne and Alamance Counties. In this table are included the number of individuals in each group, the mean plasma content of ascorbic acid and standard deviation, the mean intake and standard deviation, together with the coefficient of correlation between intake and plasma level.

Among families surveyed in any specified season, the mean

ascorbic acid content of the plasma was higher among children than it was among adults. Indeed, this is the notable difference among the plasma means, since differences between those for adult males and females were not conspicuous. The summer and fall surveys revealed higher mean plasma levels than did those conducted in winter and spring. In general, Wayne County means were lower than the corresponding ones for Alamance County.

The standard deviations of the distributions contained in Table 1 measure the degree of dispersion of the observed values given by the individuals in the various groups. In respect to plasma ascorbic acid they indicate that persons were similarly distributed in each county. The standard deviations for individual groups varied from 0.15 to 0.48 mgm per cent and were all above the 0.04 expected minimum error in the laboratory determination (9).

The average daily intakes of ascorbic acid ranged widely. Those for Wayne County were lower, giving a final average for all persons in the study of only 30.2 mgm, as compared with one of 41.7 for Alamance County. In general, the average intakes of children were somewhat higher than those for adults. The summer intake means for Wayne County, particularly that for children, were above those of the other seasons.

For Wayne County the standard deviations of intake values of individual groups varied from 11.8 to 54.4 mgm, with an overall average of 30.4 mgm. Those for Alamance varied from 17.3 to 38.1 mgm, with an average for the county of 27.7 mgm. Much of the difference between the two counties, however, lies in the wider dispersion of intake values among children in the two summer surveys. It seems unlikely, therefore, that the greater variability in the Wayne County data is attributable to the fact that foods were not grouped when the amount of the nutrient was calculated.

Significant correlation ($P < 0.05$) between ascorbic acid content of plasma and recorded intake was obtained for six of the eight groups of children and ranged from $+0.303$ to $+0.738$.

Significant correlation was also found for six of the eight groups of females of 15 years and over. There were only three instances of significant correlation among adult males, although two of the coefficients, those for Wayne County summer and spring surveys, might have been significant had the groups been larger. When age and sex were disregarded and the data summarized by season, higher correlation was obtained for data collected in summer and spring surveys in both counties. When season was disregarded and the data summarized by age and sex, significant coefficients were obtained. Finally, when the data for each county were assembled in a single table, the coefficients were still significant: + 0.395 for Wayne and + 0.416 for Alamance County.

The significance of a correlation coefficient depends not only on its size but also on the number of persons in the group to which it pertains. Hence coefficients for seasonal and age-sex subtotals are significant, although of a lower order than some of those obtained for the small subgroups which were not significant. It is noteworthy that the highest coefficients were obtained when sex, age and season were simultaneously considered.

Mexico. Corresponding statistics for the three age and sex groups of Otomi Indians are contained in Table 2, with season-

Table 2. Means of ascorbic acid blood serum content and of recorded daily food intake with standard deviations and correlation coefficients for surveyed groups of Otomi Indians, Mexico, 1943–1944.

Population Group	Number of Persons	Ascorbic Acid				
		Serum (mgm %)		Intake (mgm)		Correl. Coef.
		Mean	S.D.	Mean	S.D.	
M,F, – 15	267	1.21	0.41	51.0	38.1	+ 0.218*
M 15 +	183	1.20	0.46	164.5	102.5	+ 0.123
F 15 +	249	1.19	0.38	107.4	66.8	+ 0.147*
Total	699	1.20	0.41	100.8	83.2	+ 0.110*

* $P < 0.05$.

ality omitted. Here the average ascorbic acid content of the blood serum was 1.21 mgm per cent for children and similarly high for adults. The standard deviation for all persons surveyed was 0.41 mgm per cent and thus well above the variation inherent in laboratory procedures.

The mean daily intake of ascorbic acid for the Indian children was 51.0 mgm, while that for adult males was 164.5 and for females 107.4 mgm, both means well above the National Research Council's recommended daily allowances of from 70 to 75 mgm.

In view of the high blood content and intake of vitamin C it is not surprising that little correlation was obtained. With serum level at or near the renal threshold much of the ingested vitamin may have been excreted. The two significant coefficients, those for children and adult females, were too low to have any real meaning.

Summary. Since it is known that the administration of large amounts of ascorbic acid will increase the amount of the vitamin in the blood, the discovery of some statistical correlation between intake, as measured by the diet record, and plasma or serum content is not surprising and must be accepted as an indication that the diet records do furnish some measure of the amount of vitamin C consumed. Confirmation of this appeared recently in a paper by Kaser *et al.* (11) in which the correlation between calculated amounts of ascorbic acid in diets from a local field survey and those determined in the laboratory for 80 sample diets containing the same foods was found to be $+0.7$.

Several factors must affect the amount of correlation observed: (a) inaccuracies in the diet records and in their conversion into values of the nutrient consumed; (b) the exclusion of cooked foods from the computations in North Carolina and their inclusion without adjustment in Mexico; (c) the lag in time between ingestion of the nutrient and its appearance or disappearance from the blood; (d) the inclusion of records for a few pregnant and lactating women; and (e) especially with

the Otomi Indians, the high serum and intake levels of the vitamin which probably induced excretion of the excess.

A FOURFOLD TABLE ANALYSIS

Persons engaged in nutritional surveys are familiar with the chi-square test as applied to a fourfold table. In such a table subjects with clinical symptoms of a deficiency are divided into two groups, one containing those with a laboratory rating with respect to the nutrient concerned at or above a certain level, and the other containing persons with ratings below this level. Persons without symptoms are similarly divided for comparison in making the test. The chi-square calculated from such a table indicates whether or not association may be said to exist between the presence of symptoms and the laboratory rating as defined. The test does not indicate the amount or form of the association.

An examination of the survey data used in this analysis has been made by this method. The records were subdivided into those with intake of ascorbic acid at 40 mgm or above and those with intakes below this level. On the blood content scale a division was made at 0.6 mgm per cent. One fourfold table for each area is contained in Table 3.

The large chi-square obtained for each North Carolina group indicates that a significantly greater proportion of persons with low ascorbic acid intakes are found in the low blood content group and also that a larger proportion of individuals with low blood level falls into the low intake group, so there is significant association between intake and plasma content of the vitamin.

A comparison of the fourfold table arrangement of the data for the Mexican Otomi Indians with those for the North Carolinians indicates that only 8.2 per cent of the Indians had intakes of less than 40 mgm as compared with 75.8 per cent of the persons surveyed in Wayne County and 55.6 per cent of Alamance County residents. The proportion of persons in the Indian group with low blood level of the vitamin (36.6 per cent) was also less than the corresponding percentages for the

Blood Level (mgm %)	Ascorbic Acid Intake (mgm)							
	0–39	40+	Total	Per Cent 0–39	0–39	40+	Total	Per Cent 0–39
	Wayne Co., N. C.				Alamance Co., N. C.			
Under 0.6	181	27	208	87.0	165	78	243	67.9
0.6+	94	61	155	60.6	108	140	248	43.5
Total	275	88	363	75.8	273	218	491	55.6
Per Cent −0.6	65.8	30.7	57.3		60.4	35.8	49.5	
	$X^2 = 33.6$ $P < 0.01$				$X^2 = 29.5$ $P < 0.01$			
	Otomi Indians, Mexico							
Under 0.6	30	226	256	11.7				
0.6+	27	416	443	6.1				
Total	57	642	699	8.2				
Per Cent −0.6	52.6	35.2	36.6					
	$X^2 = 6.85$ $P < 0.01$							

Table 3. A fourfold table analysis of data pertaining to ascorbic acid blood level and intake, from population surveys in three areas.

North Carolinians. The chi-square of 6.85 for the Indians indicates some significant association between intake and blood levels.

Since vitamin C deficiency is likely to occur among persons with low intake and low blood content, the fourfold table analysis furnishes a ready method of determining the possible magnitude of the deficiency problem and its relation to intake in a surveyed population. The wide dispersion of the observed ascorbic acid intakes and blood levels pertaining to the individuals in these population groups is eliminated, however, when the data are distributed in this manner. Furthermore, the variability in individual observations may reduce the amount of correlation and limit its use statistically. We shall now return to a consideration of the correlation coefficients and of the regression equations to be derived from them.

THE REGRESSION EQUATIONS

A significant positive correlation coefficient indicates that,

on the average, blood content of the vitamin rises as intake increases. It also signifies that intake may be expected to increase as the blood level rises. Both of these relationships must be considered and may be expressed in regression equations which are computed from the standard deviations, the correlation coefficient and the mean values of blood level and intake. The form of the equation is as follows:

$$y = a + bx \qquad (1)$$

in which y = the average or expected blood content
x = a specified intake value
a = the blood content when intake is zero
and b = the rise in blood level per milligram increase in intake, i.e., the slope of the line

This equation may be modified to express the regression of intake on blood level, thus:

$$x = a' + b'y \qquad (2)$$

in which a' = the intake when the blood level is zero
and b' = the rise in intake per milligram per cent increase in blood level, i.e., the slope

These regressions are in the form of straight lines and if the correlation is of a high order may, within limits, have a prediction value when groups of persons with similar attributes are considered. The first equation enables one to compute the expected blood level of the vitamin for any specified intake value, the other the expected intake for a particular blood level. The low order of the correlation coefficients obtained for the area-wide population groups described here will not permit the application of the equations for prediction purposes to other population groups, but they will be presented and discussed briefly with reference to the observed data.

"GOODNESS OF FIT" OF THE REGRESSION EQUATIONS

North Carolina. The raw data for all persons included in the surveys of Wayne and Alamance Counties are contained in the correlation tables in Figures 1 and 2, with the equations entered and the regression lines plotted. Examination of these tables

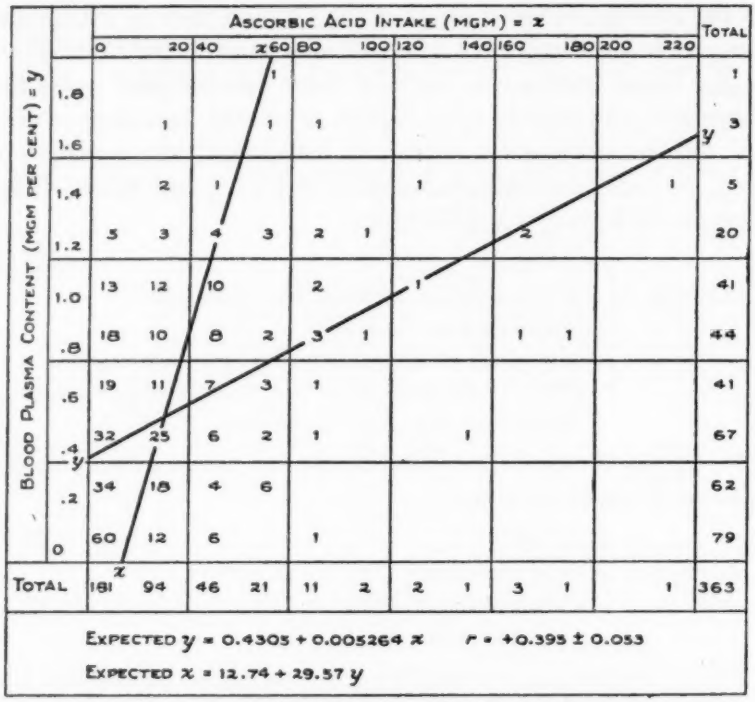

Fig. 1. Wayne County, North Carolina. Distribution of persons surveyed, according to diet record of ascorbic acid intake and blood plasma level.

indicates that the large proportion of the observations falls into the low intake-low plasma content categories, a fact that was obvious when the fourfold tables were analyzed. However, the observations in both tables extend over a range of plasma categories extending from 0 to 1.8 mgm per cent. Observations on intake are also concentrated at the lower end of the scale with only a few entries in either table of intakes of 100 mgm or over. Obviously, these North Carolinians were not distributed symmetrically with respect either to intake or to plasma level of ascorbic acid.

The raw data presented in Figures 1 and 2 emphasize "poorness" rather than "goodness of fit" inasmuch as there is little apparent drift of the observations along the regression lines. The actual trend of the data is best described when the means

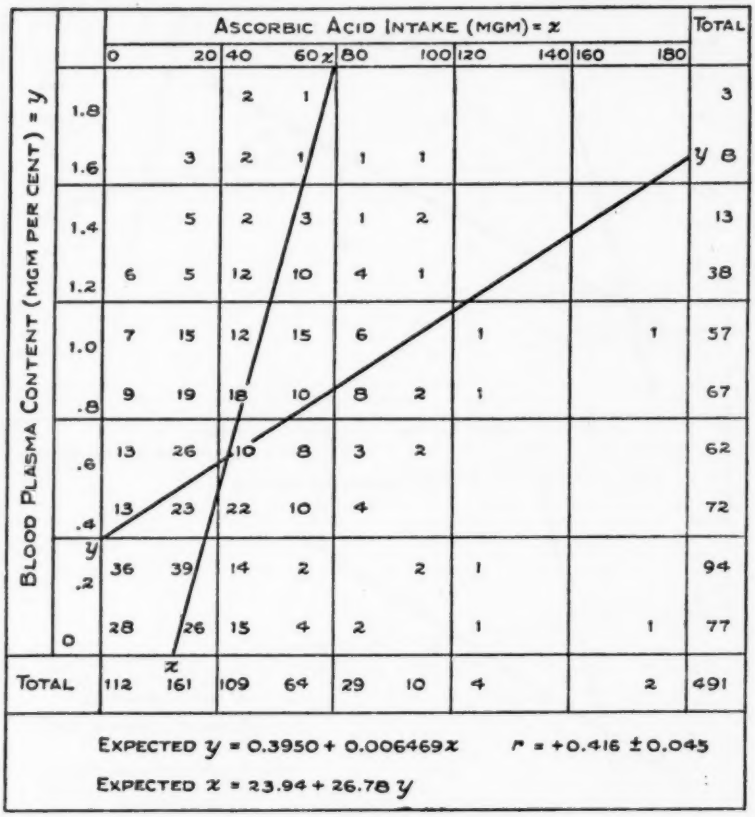

Fig. 2. Alamance County, North Carolina. Distribution of persons surveyed, according to diet record of ascorbic acid intake and blood plasma level.

of the rows and columns in the tables are plotted with the regression lines, as has been done in Figures 3 and 4. The "goodness of fit" can now be examined.

The Wayne County diagram in Figure 3 indicates that the observed means of plasma ascorbic acid content for successive intake categories lie along the regression line (y—y) for intakes under 60 mgm. At higher intake levels the plasma means are dispersed over a wide range of values which are actually based on observations from a very few persons. At intakes of 140 mgm and over all plasma means lie below the regression

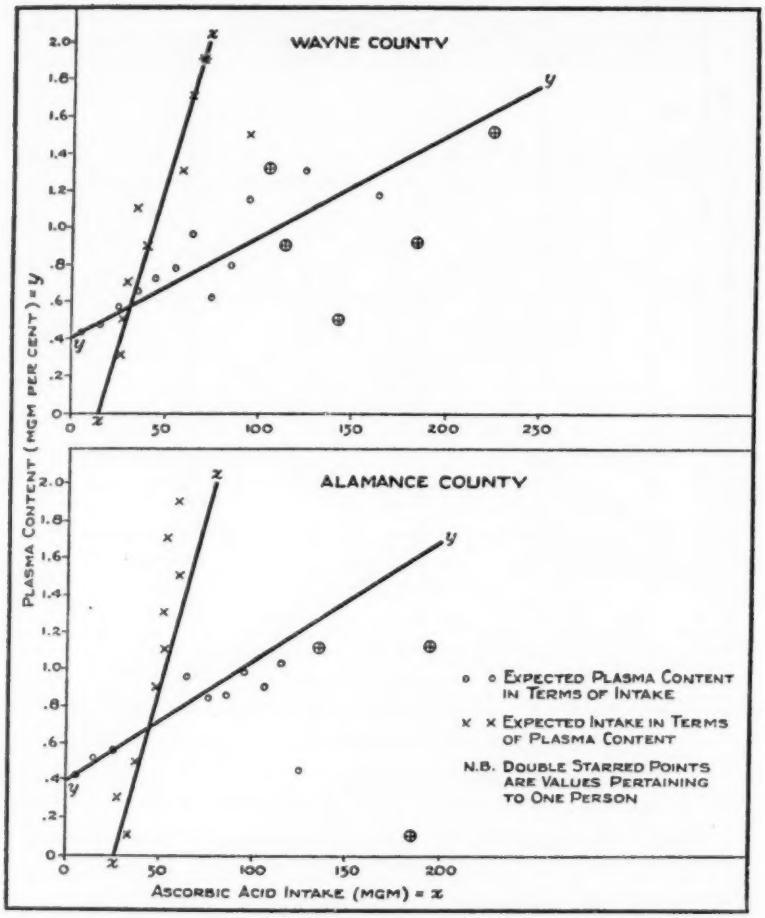

Fig. 3. North Carolina. Comparison of the trend of observed means with that of the corresponding rectilinear regression line for all surveyed persons.

line instead of on either side of it. In other words, the actual rise in plasma ascorbic acid content per milligram increase in intake diminishes at higher intake levels so that the trend of the means is curvilinear not rectilinear. The plasma means for Alamance County reveal this nonlinearity more clearly, inasmuch as all values for intakes of 70 mgm and over fall below the computed line.

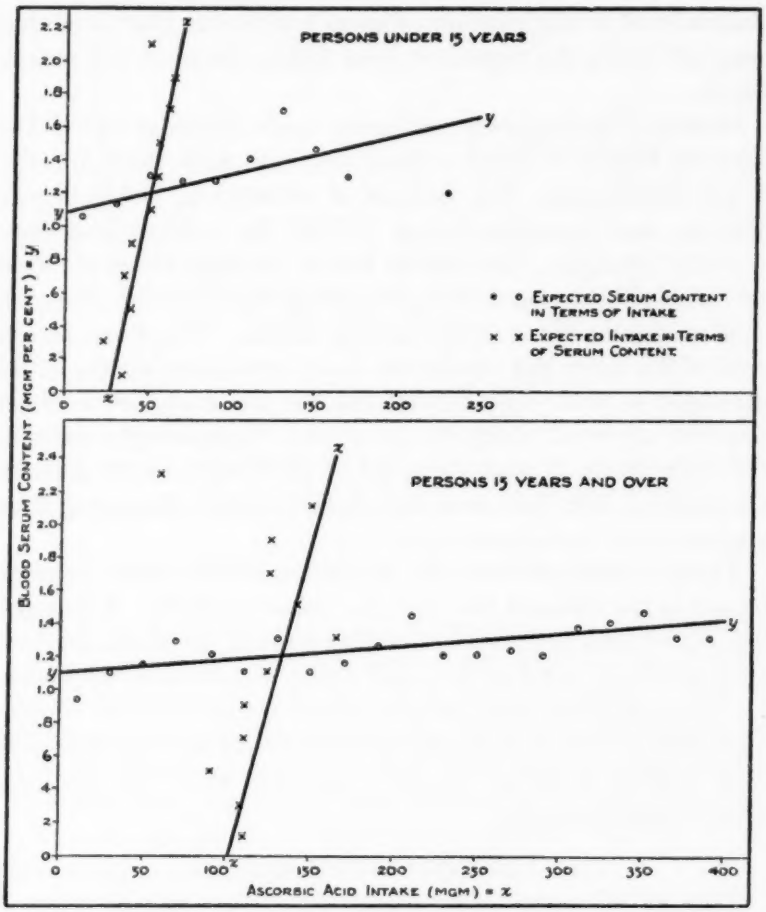

Fig. 4. Mexican Otomi Indians. Comparison of the trend of observed means with that of the corresponding rectilinear regression line.

The departure from linearity of the mean intakes in terms of plasma content is not as pronounced as that of the plasma means, and the intake means are less variable. Those for Alamance County, however, rise very little for plasma levels of 1.0 mgm per cent and over.

Ascorbic acid potential or latent deficiency states may be expected more frequently among persons with low intake and low

plasma level of the vitamin. Figure 3 indicates that over this range of values the regression lines follow the observed means closely.

Mexico. The diagrams pertaining to the Mexican Otomi Indians in Figure 4 afford a sharp contrast with those for the North Carolinians. The amount of correlation, although significant, was negligible, being + 0.218 for children and only + 0.124 for adults. The reason lies in the high mean ascorbic acid level of both population groups together with the excessive intakes among the pulque-drinking adults. The mean serum level of 1.2 mgm per cent must have approximated the renal threshold so that little further rise for the group as a whole could be expected whatever the intake. Interestingly enough, the mean intake of adults reached its peak when serum content attained 1.2 mgm per cent and then dropped, suggesting that appetite may have been sated.

There is some curvilinearity in the trend of the serum content means of the children but none for those of adults. A straight line is probably also the best-fitting one for the mean intakes, although their trend in the adult group is definitely not linear.

The correlation tables for the Otomi Indians are not shown. The distributions of both children and adults were symmetrical with respect to serum ascorbic acid but were asymmetrical with respect to intake.

II. The Relationship Defined

The Objective

It has been demonstrated that a simple correlation technique does not adequately describe the form of the association existing between ascorbic acid intake, as measured by the diet record, and its level in blood serum or plasma. Furthermore, the intake distributions for all the population groups presented were asymmetric in that the peaks were left of center. A technique is needed, therefore, that will describe the curvilinear trend of the observed means and render the intake distributions more symmetrical.

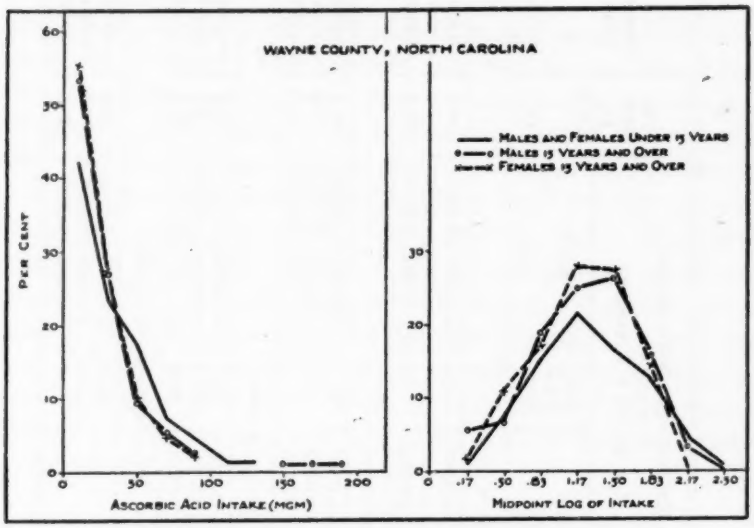

Fig. 5. Percentage distribution of persons surveyed according to ascorbic acid intake when plotted to arithmetic and logarithmic scales.

Both objectives may be realized by setting up the correlation tables in terms of the logarithms of the intake values, leaving the blood content scale in arithmetic progression. This realignment will push the peaks of the intake distributions to the right by extending the scale for low values and compressing that for higher ones. Figure 5 illustrates the effect of this redistribution upon the intake frequencies for persons included in the Wayne County survey.

Nine population groups have been retained for the present analysis with three for each area: children under 15 years, and males separate from females for persons of 15 years and over. A correlation table was set up for each group and new correlation coefficients and regression equations were computed. The relationship described by these calculations is that existing between the observed blood levels and the logarithms of the intakes. It is similar to that obtained from the biological assay in which the response to a drug is measured in terms of the logarithm of the dose except that here we have the distributions of persons

Table 4. Constants of regression equations describing the association between ascorbic acid in blood serum or plasma and the logarithm of the intake.

Population Group		No. of Persons	Expected Ascorbic Acid in Blood Serum or Plasma (mgm per cent) = y; y = a + b(log x)		Expected Geometric Intake (mgm) = x; Log x = Log a′ + y(Log b′)			Per Cent Increase	Correl. Coef.
Sex	Age		a	b	Log a′	Anti-log a′	Log b′		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			WAYNE CO., N. C.						
M,F	−15	139	0.3515 ± 0.0314	+ 0.3023 ± 0.0680	1.0311 ± 0.0367	10.7	+ 0.4121 ± 0.0927	158.3	+ 0.353*
M	15+	96	0.0869 ± 0.0358	+ 0.2760 ± 0.0761	1.0459 ± 0.0450	11.1	+ 0.4364 ± 0.1203	173.1	+ 0.347*
F	15+	128	0.0994 ± 0.0300	+ 0.3541 ± 0.0720	0.9737 ± 0.0364	9.4	+ 0.4491 ± 0.0913	181.2	+ 0.399*
			ALAMANCE CO., N. C.						
M,F	−15	181	0.2512 ± 0.0307	+ 0.3915 ± 0.0952	1.3810 ± 0.0229	24.0	+ 0.2182 ± 0.0531	65.3	+ 0.292*
M	15+	121	0.0029 ± 0.0344	+ 0.3143 ± 0.0981	1.3895 ± 0.0505	24.6	+ 0.2482 ± 0.0775	77.1	+ 0.279*
F	15+	189	0.0833 ± 0.0258	+ 0.3433 ± 0.0803	1.3326 ± 0.0223	21.5	+ 0.2566 ± 0.0601	80.6	+ 0.297*
			OTOMI INDIANS, MEXICO						
M,F	−15	267	0.7081 ± 0.0240	+ 0.3197 ± 0.0660	1.2711 ± 0.0213	18.7	+ 0.2526 ± 0.0522	78.9	+ 0.284*
M	15+	183	0.9282 ± 0.0337	+ 0.1283 ± 0.1131	2.0580 ± 0.0337	114.3	+ 0.0539 ± 0.0475	13.2	+ 0.083
F	15+	249	0.8816 ± 0.0239	+ 0.1605 ± 0.0715	1.7843 ± 0.0212	60.9	+ 0.1237 ± 0.0551	33.1	+ 0.141*
			OTOMI INDIANS, MEXICO, WITH WEIGHT AT THE MEAN[1]						
M,F	−15	267	0.7665	+ 0.2827 ± 0.0695	1.3270	21.2	+ 0.2065 ± 0.0508	60.9	+ 0.242*
M	15+	183	0.9940	+ 0.0973 ± 0.1198	2.0784	119.8	+ 0.0368 ± 0.0455	8.9	+ 0.060
F	15+	247	0.8728	+ 0.1659 ± 0.0736	1.7862	61.1	+ 0.1216 ± 0.0539	32.3	+ 0.142*

* $P < 0.05$.
[1] These are coefficients for log intake versus blood content with weight held constant.

in each population both with respect to response (blood level) and dose (intake). The problem may well be considered from this viewpoint, since, if the diet records furnish an adequate measure of actual intake, the relationship should resemble that observed when known doses of ascorbic acid are administered.

If the new equations afford a better "fit" for the observed data, the correlation coefficients should be higher than those contained in Tables 1 and 2 for corresponding population groups. Actually some were a trifle higher and others not as good (Table 4); and since the differences were not significant, nothing has been gained by the application of the more elaborate technique. We shall, however, continue with the analysis since it offers a method which may be of value in other studies of a similar character.

THE SEMILOGARITHMIC REGRESSION EQUATIONS

Expressed in the symbols used in equations (1) and (2) the new regression equations are:

$$\text{Expected blood content: } y = a + b(\log x) \qquad (3)$$

$$\text{Expected log intake: } \log x = \log a' + y(\log b') \qquad (4)$$

The b in equation (3) is the increase or decrease in milligrams per cent of blood content per integer change in log intake. The antilog of b' in equation (4) signifies the rate or per cent of change in x (intake) for each milligram per cent increase or decrease in the observed y (blood content). Since b and log b' are constants of figures computed from the regression equations plot as straight lines on a semilogarithmic scale.

Constants of the regression equations with their standard errors for each of the nine population groups are contained in Table 4. Antilog values of the constants in equation (4) are also given as well as the new correlation coefficients. In Figures 6 and 7 the lines indicating the rise in the expected blood content of ascorbic acid (response) in terms of increasing log intake (dose) are shown in the upper drawings and the complementary lines showing the regression of log intake upon blood

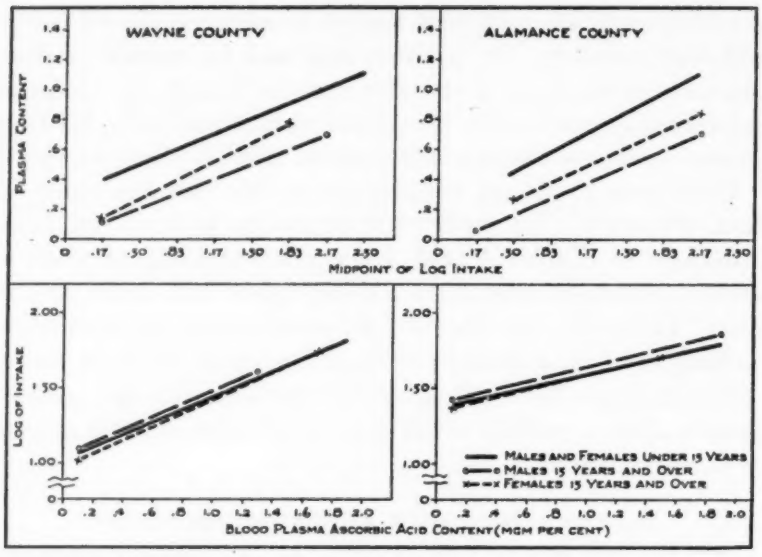

Fig. 6. North Carolina. The regressions of (a) blood plasma ascorbic acid content on log intake and (b) log intake on plasma level.

level are contained in the lower diagrams. The lines are drawn from the midpoint of the first scale interval to that of the last for which data were available.

North Carolina. Increases in plasma ascorbic acid content (*b* constants, column 5 in Table 4) for rising values of log intake, obtained from data for the three population groups in Wayne County, do not differ significantly, with the result that the slopes of the lines (Figure 6) may be considered essentially parallel. The same is true of the slopes of the corresponding lines computed from data for Alamance County. Evidently similar responses were given by these six population groups as dosage increased. The heights of the lines above the bases of the diagrams, as determined by the *a* constants, column 4 of Table 4, do differ significantly, however, when that for children in each county is compared with the levels for adults.

The two diagrams in the lower part of Figure 6 show the regression of log intake of ascorbic acid on plasma level as computed from equation (4) for each of the six North Carolina

groups. Here, not only the slopes but also the levels of log intake are similar for the three groups in each county.

An explanation of these phenomena may lie in the differing physiological requirements of children and adults. The family was the unit of observation and the food consumed was derived largely from the family table and was available to all its members. Apparently the plasma content of ascorbic acid attained under a common intake regimen was appreciably less for adults than for children in these two North Carolina counties.

Mexico. The constants for equations (3) and (4) computed from data for the three groups of Otomi Indians are also contained in Table 4 but the lines plotted in Figure 7 are derived from the constants in the last set of equations in the table in which weight has been held constant at the mean for each group. The effect of weight upon the correlation between ascorbic acid intake and blood content will be discussed presently. When its effect is considered the a and log a' constants in the last set of equations, with one exception, are raised somewhat and the b and log b' constants, also with one exception, are lowered slightly.

Among the Indians, as among the North Carolinians, the computed ascorbic acid serum levels (Table 4, column 4) differ significantly while the slopes (b constants) do not. The computed log intake values for the Indians, on the other hand, differ both as to level and slope. (Figure 7.) The regression line depicting intake for adult males lies high above the others and does not rise significantly, while that for children starts from a low level and rises rapidly.

Unlike the North Carolinians differences between the Indian groups are greater with respect to ascorbic acid intake than as to serum content. The varying quantities of pulque drunk probably account for intake differences. If so, the net effect of dietary differences has been to raise serum content to essentially similar levels. The question raised by these comparisons is what the physiological character may be that enables children to attain a blood ascorbic acid level as high or higher than that

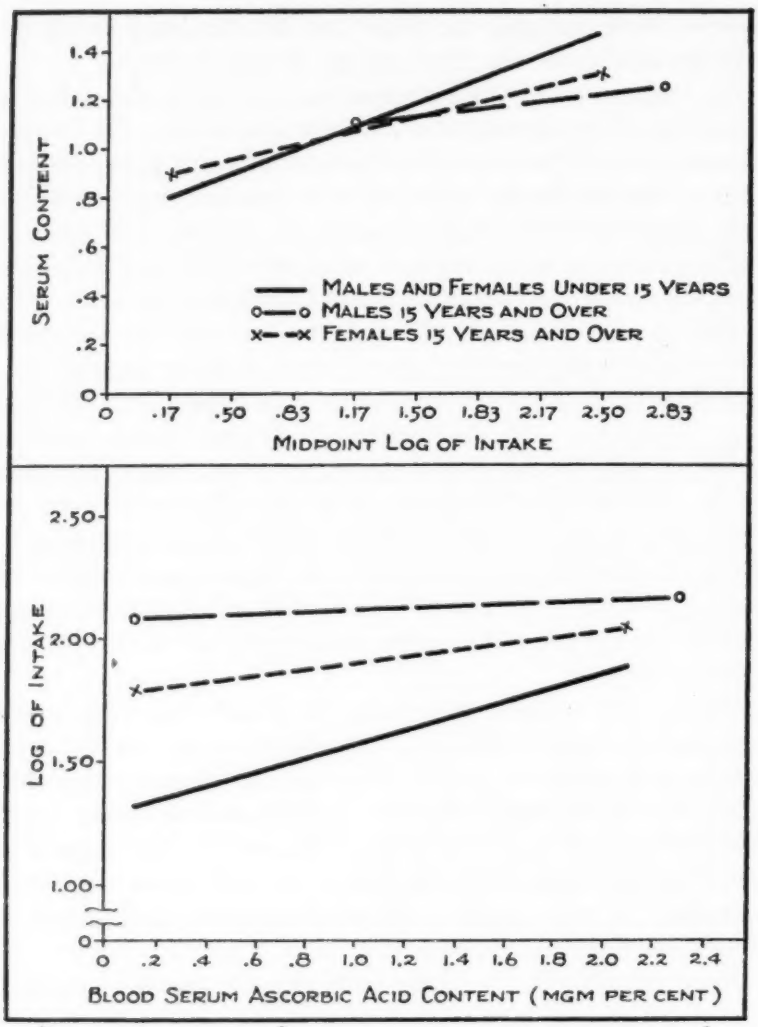

Fig. 7. Mexican Otomi Indians. The regressions, with weight at the mean, of (a) blood serum ascorbic acid on log intake and (b) log intake on serum level.

of adults on smaller intakes. One obvious group difference is that of weight.

THE EFFECT OF WEIGHT

A consideration of weight is important for two reasons. Ob-

viously weight of children under 15 years is associated with normal growth, while for persons of 15 years and over increase in weight is not necessarily a function of growth. A second reason is that the increase in the total amount of ascorbic acid in body tissues accompanying growth is not reflected in the unit of measurement employed in the laboratory which is the amount contained in 100 cc of blood. If the effect of growth is not included in one of the variables in the correlation it should be excluded from the other.

Presumably total food consumption increases with growth so that the average caloric intake of adults is probably greater than that of children from 2 to 14 years of age. As a corollary

Table 5. Correlation coefficients indicating the amount of association for each population group between (a) total calories and weight, (b) total calories and ascorbic acid intake, and (c) log ascorbic acid intake and weight.

Population Group		Total Calories Versus Weight	Total Calories Versus Ascorbic Acid Intake[1]	Log Ascorbic Acid Intake Versus Weight
Sex	Age			
		OTOMÍ INDIANS, MEXICO		
M,F	−15	+0.506*	+0.370*	+0.326*
M	15+	+0.368*	+0.696*	+0.321*
F	15+	+0.363*	+0.566*	+0.233*
		WAYNE CO., N. C.		
M,F	−15	+0.243*	+0.220*	−0.092
M	15+	−0.010	+0.342*	−0.108
F	15+	−0.015	+0.230*	−0.047
		ALAMANCE CO., N. C.		
M,F	−15	+0.291*	+0.070	+0.005
M	15+	−0.015	+0.292*	−0.116
F	15+	+0.033	+0.183*	−0.161*

[1] Distributions on an arithmetic scale.
* $P < 0.05$.

one might also expect ascorbic acid intake to increase with growth i.e., weight, and hence with total food consumption. Table 5 contains the correlation coefficients indicating the degree of association between total calories and weight, total calories and ascorbic acid intake, and that between log ascorbic acid intake and weight, for each population group.

For the Otomi Indians significant positive correlation was obtained for each age and sex group between total calories and weight. The coefficient for children (Table 5) is highest as might be expected for the reason given above. The correlation between total calories and ascorbic acid intake is also positive and significant and is higher for adults than children. The consumption of pulque enters the picture again since 12 per cent of the calories consumed came from the protein and alcohol in pulque (6). As much as 2 per cent of the caloric intake was attributed to alcohol in pulque drunk by children from 1 to 3 years of age and the proportion increased to 15 per cent for males in the 21 to 50 year age group. A significant correlation between total calories and vitamin C consumed is, therefore, not unexpected.

Among North Carolinians the picture is conspicuously different. A small significant correlation between total calories and weight is indicated for children only. All three Wayne County groups exhibit some significant positive correlation between total calories and ascorbic acid intake, while data for adults only in Alamance County give small significant positive coefficients.

Logarithms of ascorbic acid intakes were used for calculating the correlation with weight. Again data for the Indians give significant positive correlation but only one small negative coefficient, that for adult females in Alamance County, is significant for the North Carolinians.

Under the circumstances no attempt has been made to add weight to the variables considered in the anaylsis of the data for North Carolina. From data pertaining to the Otomi Indians, however, a third set of equations was computed by a

partial correlation technique by which the regression of blood content upon log intake and weight, as well as the regression of log intake upon blood content and weight, could be computed. These equations will not be presented or discussed in detail but the effect of weight at the mean upon blood content and log intake for each population group has been added to the a and log a' values in the final set of equations in Table 4, from which computed points are plotted in Figure 7.

The coefficient signifying the regression of blood content on weight was not significant in any of the three newly computed equations. That indicating the regression of log intake on weight was significant and, interestingly enough, was virtually the same for the three Indian groups in that the rate of increase

Table 6. Relative adequacy of the mean ascorbic acid intake (geometric) in each population group in terms of average weight and blood vitamin C level.

Population Group		Geometric Mean Ascorbic Acid Intake (mgm)	Mean Weight (kgm)	Mean Blood Ascorbic Acid Content (mgm Per Cent)
Sex	Age			
		Otomi Indians, Mexico		
M,F	−15	37.79 ± 1.93	21.81 ± 0.52	1.21 ± 0.025
M	15+	132.66 ± 6.73	54.96 ± 0.56	1.20 ± 0.034
F	15+	85.35 ± 4.23	47.28 ± 0.44	1.19 ± 0.024
		Wayne Co., N. C.		
M,F	−15	22.04 ± 1.99	32.32 ± 0.95	0.76 ± 0.034
M	15+	17.07 ± 1.89	67.73 ± 1.44	0.43 ± 0.038
F	15+	16.25 ± 1.38	61.49 ± 1.25	0.53 ± 0.033
		Alamance Co., N. C.		
M,F	−15	37.15 ± 2.05	32.35 ± 0.84	0.87 ± 0.032
M	15+	32.20 ± 2.36	69.53 ± 1.00	0.48 ± 0.036
F	15+	30.53 ± 1.64	61.31 ± 0.90	0.59 ± 0.027

in ascorbic acid intake per kilogram of weight was 2.8 per cent for each. Mean weight differences between the groups, therefore, call for an average intake among adult females of twice that of children, while the intake of adult males should be 2.5 times that of children.

Table 6 contains the mean values for each population group for (a) ascorbic acid intake (geometric), (b) weight, and (c) blood content. Among the Otomi Indians the observed geometric mean intakes of adults more than fulfill the weight requirements indicated by the regression coefficients, while the mean serum levels attained are 1.2 mgm per cent for each group. Among persons surveyed in North Carolina the geometric mean intakes of children are actually higher than those of adults in spite of the differences in weight. If the 2.8 per cent rise in intake per kilogram of weight may be applied to data for the North Carolina groups, the geometric mean intakes of children should be multiplied by the following factors to take care of the differences in weight:

	Wayne County	*Alamance County*
Adult Males	2.7	2.8
Adult Females	2.2	2.2

We may not be justified in applying these correction factors to data for the North Carolinians. Obviously, however, the geometric mean intakes for adults in North Carolina could not be expected to achieve plasma levels equivalent to those attained by children.

TISSUE RESERVES OF VITAMIN C

Since theoretical blood ascorbic acid means computed from the semilogarithmic equations given in Table 4 pursue a curvilinear course when plotted to an arithmetic scale, the trend of observed and theoretical means with respect to tissue stores of the vitamin may be investigated. Although these equations do not approach finite limits, within the range of observed values, blood levels rise more slowly as intake is increased.

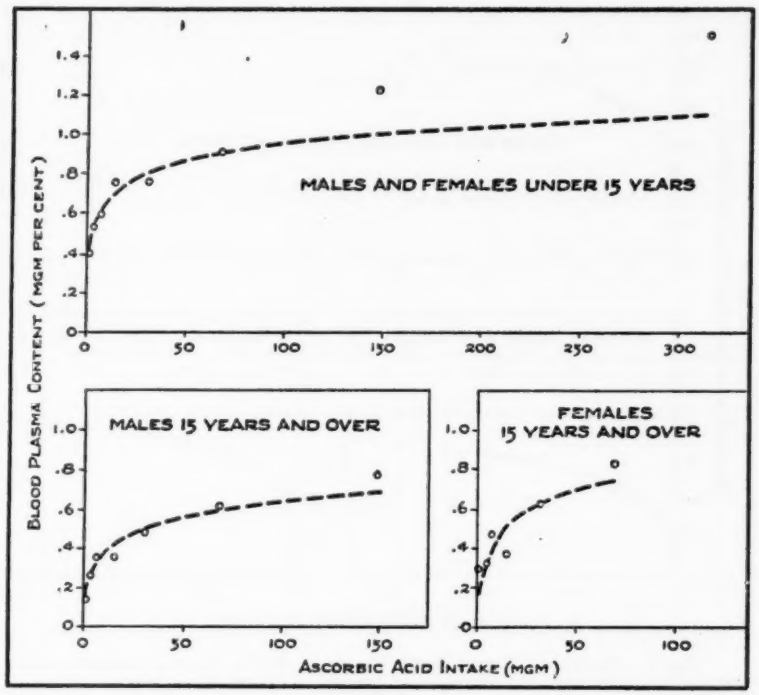

Fig. 8. Wayne County, North Carolina. Tissue stores of ascorbic acid as indicated by the level of response (plasma content) to equivalent intakes.

Figures 8 to 10 contain the observed blood content means with the corresponding regression lines plotted to an arithmetic scale for the various population groups, exclusive of that for adult male Indians for whom there was no significant correlation between ascorbic acid intake and blood level. The observed means are plotted at the midpoints of the logarithmic intervals from the correlation tables with antilogs: 1.47, 3.16, 6.81, 14.7, 31.6, 68.1, 147 mgm, etc. On an arithmetic scale the distance between these points widens rapidly.

For comparing the observed and computed ascorbic acid mean blood levels of the various groups, those pertaining to an intake range of from 47 to 99 mgm have been selected, with a geometric intake midpoint of 68.1 mgm. At this point the regression lines lie close to the observed means and the number of ob-

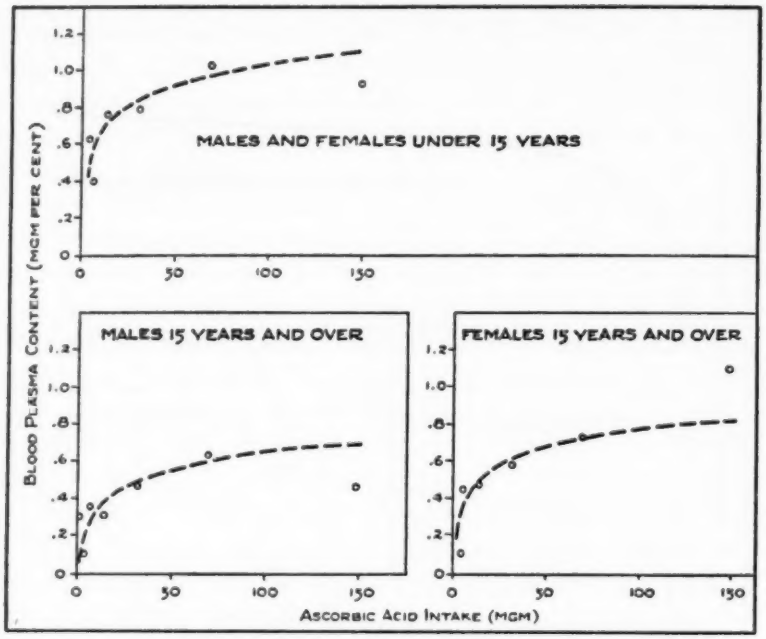

Fig. 9. Alamance County, North Carolina. Tissue stores of ascorbic acid as indicated by the level of response (plasma content) to equivalent intakes.

servations in each group was large enough to afford fairly stable means. Table 7 contains the observed and computed mean blood levels at geometric intake midpoints of 68 and 147 mgm.

If the individuals in these nine population groups had been selected at random, similar blood levels of ascorbic acid for the same intake values might be expected. The groups are known to differ, however, as to age, sex, race and weight but none of these factors will explain why adult Indians with intakes ranging from 47 to 99 mgm attained blood levels of 1.25 and 1.22 mgm per cent, while the same intakes give corresponding values for North Carolina adults of from 0.62 to 0.84 mgm per cent. When the regression lines are extended to the midpoint of the next log intake interval, antilog 147 with a range of from 100 to 213 mgm, amounts which should provide enough ascorbic acid to supply any weight requirements, the discrepancies in blood

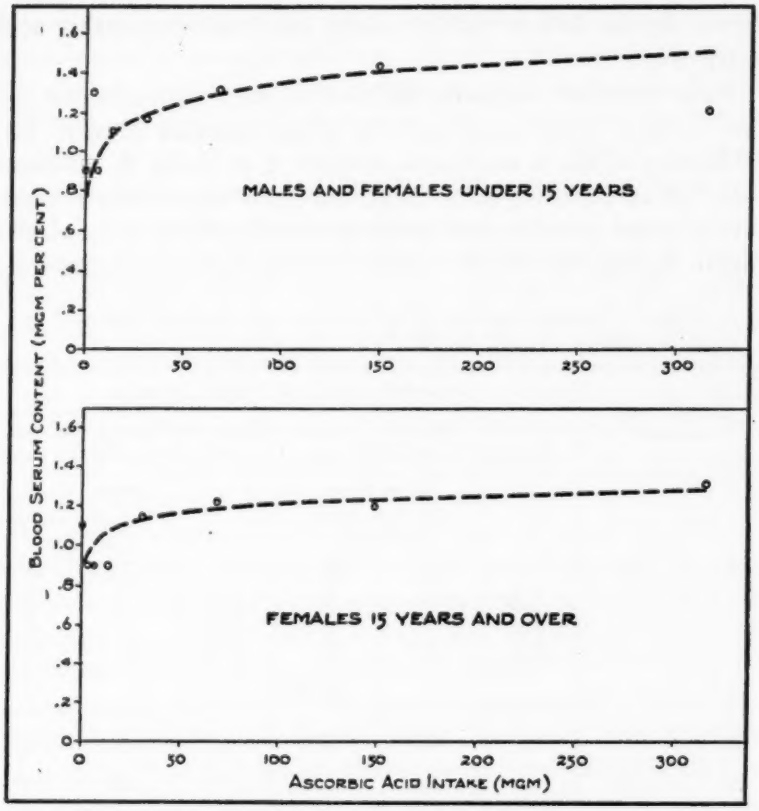

Fig. 10. Mexican Otomi Indians. Tissue stores of ascorbic acid as indicated by the level of response (serum content) to equivalent intakes.

levels between adult Indians and North Carolinians are still not met. Something else enters the picture.

If we look back along the regression lines in Figure 10 pertaining to adult Indians to a midpoint of 32 mgm we find blood levels of 1.12 mgm per cent for both males and females, indicating that they were in a state approximating tissue saturation at a time when ascorbic acid intake was below anything considered adequate for normal nutrition. Blood plasma content for North Carolinians, on the other hand, fell below this amount on intakes as high as 147 mgm daily. Obviously, the recorded

intake figures do not tell the entire story about ascorbic acid nutriture.

Basic nutriture evidently differed for these groups when the diet surveys were made and the blood samples drawn. Examination of the *a* constants, column 4 in Table 4, indicates this. On an arith-log scale these constants represent the theoretical blood ascorbic acid content when intake was equal to 1 mgm. Among the North Carolina adults these constants were

Table 7. Varying responsé (blood ascorbic acid content) achieved by population groups receiving the same dose (log intake).

Population Group		Ascorbic Acid Log Intake Interval					
		Geometric Midpoint 68.1 mgm, Interval Range 47–99 mgm			Geometric Midpoint 147 mgm, Interval Range 100–213 mgm		
Sex	Age	Number of Persons	Mean Blood Content (mgm Per Cent)		Number of Persons	Mean Blood Content (mgm Per Cent)	
			Observed	Computed		Observed	Computed
		WAYNE CO., N. C.					
M,F	–15	31	0.85	0.91	6	1.23	1.01
M	15+	15	0.62	0.59	3	0.77	0.69
F	15+	19	0.84	0.75	0	—	—
		ALAMANCE CO., N. C.					
M,F	–15	69	1.02	0.97	9	0.92	1.10
M	15+	42	0.63	0.58	4	0.45	0.68
F	15+	54	0.72	0.71	3	1.10	0.83
		OTOMI INDIANS, MEXICO					
M,F	–15	99	1.30	1.29	22	1.44	1.40
M	15+	31	1.25	1.16	94	1.19	1.21
F	15+	86	1.22	1.18	110	1.20	1.23

less than 0.1 mgm per cent while among Indian adults they were approximately 1.0 mgm per cent. The *b* constants were similar for the six North Carolina groups as well as for the Indian children, indicating a similar rise in blood level per log integer increase in intake. Obviously, therefore, the level of blood ascorbic acid for the North Carolina adults would never rise to that of the children with equivalent intakes.

Tissue reserves of the vitamin were evidently low among North Carolina adults, and weight requirements (for saturation) as to intake were not being supplied. While average daily intakes varied among individuals and although mean plasma levels were higher for persons with larger intakes, among adults the impact of the larger consumption was not sufficient to raise the level of tissue reserves of the groups to the saturation point. Among the Indians, on the other hand, both children and adults, tissue reserves of ascorbic acid were virtually at saturation level when the diet survey was made, and although individuals varied as to their consumption, the period of observation was too short to permit low intakes to affect the nutritional status of the groups adversely.

It should be noted that the blood specimens were drawn just preceding, during, or shortly after the week the diet was recorded. This analysis has been based on the assumption that the recorded diet did not deviate significantly from that of any week covered by the observations on individuals of a given family. We may not know intake on the day just before the blood sample was drawn, but it seems unlikely that the picture of ascorbic nutriture afforded by these data would be altered appreciably by some discrepancy between the recorded intake and that just prior to the taking of the blood specimen.

Summary and Conclusions

A statistical analysis has been performed to determine the existence, degree, and form of association between the average daily intake of ascorbic acid, as given by the seven-day diet record, and the amount found in blood serum or plasma in the

laboratory examinations. The data were obtained from nutrition surveys of white families in the rural sections of Wayne and Alamance Counties of North Carolina in 1942–1944 and from a survey of Otomi Indians in four villages about 75 miles from Mexico City in 1943–1944. Ascorbic acid was chosen for specific investigation.

The statistical techniques employed in the initial stage of the analysis have included the computation of means, standard deviations, and correlation coefficients for population groups specific for age, sex, season of survey, and area. Fourfold tables for the data by area were set up for the chi-square test. Rectilinear regression equations were computed for populations on an area basis and their goodness of fit examined. Later, because of the slight curvilinearity of the existing relationship and because of the asymmetry of the intake distributions, new correlation coefficients and regression equations were computed from the logarithms of ascorbic acid intakes and the blood levels in arthmetic progression. The effect of weight was analyzed by a partial correlation technique. The object has been to ascertain whether by these statistical maneuvers the existing relationships could be adequately described.

I. *The Preliminary Reconnaissance.* The first phase of the analysis revealed significant correlation between ascorbic acid intake and plasma content for fifteen of the twenty-four North Carolina groups examined. When data were assembled on a county basis the coefficients were: $+0.395$ for Wayne and $+0.416$ for Alamance County. Significant coefficients were higher when season, age and sex as well as county were considered simultaneously. Data pertaining to the Mexican Otomi Indian children and females of 15 years and over gave significant correlation of a low order.

This significant association between ascorbic acid intake, as measured by the diet record, and blood content indicated (a) that higher blood levels on the average accompanied higher intakes and *vice versa*, and (b) that higher intakes were likely to be found among persons with higher blood content and *vice*

versa. Factors operating against a closer association were probably (a) inaccuracies in the estimation of ascorbic acid consumed, (b) the lag in time between ingestion of the vitamin and its appearance or disappearance from the blood stream, (c) the lack of homogeneity within the population groups, particularly those containing pregnant and lactating women, and (d) the excretion of the vitamin when tissue stores and blood levels are high, as in the case of the Otomi Indians, with the result that blood levels do not increase in accordance with increasing intakes.

The association of a state of unsaturation among the North Carolinians with low intakes was demonstrated by the fourfold table analysis. Fewer persons with such conditions were observed among the Otomi Indians.

A comparison of the trend of blood content means at successive ascorbic acid intake levels with that of the regression line indicated that the true relationship was curvilinear. In other words, the rise in mean blood level of the vitamin was greater when intake was low than when it was high. In the range where unsaturation occurs, however, with blood content below 0.6 mgm per cent and intake below 40 mgm, the rectilinear regression equation satisfactorily defines the relationship.

Examination of the mean intake values for successive categories of ascorbic acid blood content reveals that this relationship is generally rectilinear at lower blood levels. If and when, however, a state of tissue saturation is attained, mean intake, too, may drop or tend to rise more slowly.

II. *The Relationship Defined.* Although the goodness of fit of the regression lines was not significantly improved by the substitution of log intake values for those in arithmetic progression, differences between groups specific for age, sex, and area with respect to their response (blood content) to the logarithm of the dose (ascorbic acid intake) have been examined and discussed.

Among persons in the six North Carolina groups the rise in blood content per log integer rise in intake was similar, so that

the regression lines pursued essentially parallel courses. Their levels differed, however, with the line for children lying above the lines for adults in each county. Increases in log intake among adults and children for each milligram per cent rise in blood content were also similar, while the differences in level of the regression lines were negligible.

Among the Mexican Otomi Indians wide group differences in log intake levels were associated with similar serum content of ascorbic acid.

Weight was positively associated with total calories and with log ascorbic acid intake among the Indians. Among the North Carolinians there was some correlation between weight and total calories for children only and there was no positive association between weight and log intake of ascorbic acid.

The lower level of response (blood content) to similar dosage (log intake of the vitamin) among the adult North Carolinians is believed to have been due to low tissue reserves. The high blood ascorbic acid content among the Indians at low recorded intake values suggest that they had attained a tissue saturation that persisted at least during the period of the survey.

The interpretation of the results of this analysis must be accepted with reservation in view of the low order of statistical correlation found. The diet record does afford some measure of ascorbic acid intake, however, and a demonstration of various statistical methods for describing the inherent relationships seemed of value.

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DEMOGRAPHIC CHARACTERISTICS OF WOMEN IN "WHO'S WHO"

CLYDE V. KISER AND NATHALIE L. SCHACTER[1]

SINCE the appearance of Galton's HEREDITARY GENIUS in 1869 and ENGLISH MEN OF SCIENCE in 1875[2] numerous studies of distinguished persons have been made. Some of these, like Galton's classics, have been prompted mainly by an interest in eugenics. Among these are studies by Huntington and Whitney[3] and by Cattell.[4] Among the studies prompted by other or broader interests are those by Visher,[5] Taussig and Joslyn,[6] Geisert,[7] and Moore and Worob.[8]

Most of the studies based upon directories of persons of distinction have related mainly or entirely to men. To the writers' knowledge, the only previous statistical study relating exclusively to women in WHO'S WHO IN AMERICA is one published by Cope[9] twenty-one years ago and relating to 1,000 (or

[1] From the Milbank Memorial Fund. This paper was presented at the Assembly of the International Union for the Scientific Study of Population, held in Geneva, Switzerland, August 27–September 3, 1949.

[2] Galton, Francis: HEREDITARY GENIUS; An Inquiry Into Its Laws and Consequences. London, MacMillan, 1869.

———: ENGLISH MEN OF SCIENCE. New York, D. Appleton and Company, 1875.

[3] Huntington, Ellsworth and Whitney, Leon F.: THE BUILDERS OF AMERICA. New York, Morrow, 1927. (Based upon data for a sample of men and women in the 1926–1927 edition of WHO'S WHO IN AMERICA.)

[4] Cattell, James McKeen: Families of American Men of Science. *Scientific Monthly*, 1917, IV, pp. 248–262 and V, pp. 368–377. (Relating to 1,000 scientists starred for special eminence in AMERICAN MEN OF SCIENCE.)

[5] Visher, Stephen Sargent: GEOGRAPHY OF AMERICAN NOTABLES. Indiana University Studies, Vol. 15, Bloomington, Indiana University, 1928.

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[8] Moore, Harry Estill and Worob, Sidney R.: Place of Education and Residence of Eminent Southerners. *Social Forces*, May, 1949, xxvii, No. 4, pp. 408–412.

[9] Cope, Persis M.: The Women of "Who's Who": A Statistical Study. *Social Forces*, December, 1928, vii, No. 2, pp. 212–223. (Note: The sample of 1,000 encompassed the names beginning with A-L inclusive and about one-half of those beginning with M.)

about one-half the total) women listed in the 1926–1927 edition of WHO'S WHO IN AMERICA. The present study relates to the distribution and characteristics of virtually all women in the last edition of WHO'S WHO IN AMERICA.[10] It was carried out in the belief that, despite certain limitations to be described later, it would yield findings of interest to sociologists and demographers.

The increasing "emancipation of women" and desires of women for a "career" are mentioned frequently as factors underlying the long-time decline in the birth rate and the relatively low fertility of urban areas in countries of Western civilization. The emancipation has consisted in marked extensions of educational and employment opportunity and in legal and political rights of women. In short, it has meant the liberation of women from exclusively maternal and domestic roles, especially in urban areas of Western countries.

The demographic influence of these factors, of course, would be virtually negligible if it were restricted simply to women of national prominence.[11] Nevertheless, it was believed that, despite their small number, women such as those in WHO'S WHO are among the most "emancipated" and are among those who have most effectively translated their desires for a career into reality. For this reason the present study of modest scope was undertaken.

The scope of the study is limited by the data provided in the biographies, which generally follow a standard pattern as to type of information afforded. On the basis of the printed bi-

[10] WHO'S WHO IN AMERICA. Volume 25, 1948–1949, Chicago, The A. N. Marquis Company, 1948.

[11] "The most conspicuous extension of the conception of career in the twentieth century and a further step in its democratization is its application to women's work. At the outset of the feminist movement there was a presumption that only the woman with exceptional talent—the great actress or the great singer—was justified in having a career, with all that it meant in the repudiation of ordinary domestic and family duties. Today, however, the term is used for any self-supporting business or professional position outside the home. Outstanding talents and gifts are not required. A career for women has come to mean the carrying on of distinctive individual activity as against being merged in the family group." Everett, Helen: *Career.* THE ENCYCLOPEDIA OF THE SOCIAL SCIENCES. New York, Macmillan, 1930, Vol. III, p. 226.

ographies it was possible to code for machine tabulation data relating to occupation or field of distinction, state of birth, state of residence, size of community in which the person was born and in which she resided, educational attainment, marital status, times married, age at marriage, number of children ever born, and, for a relatively small proportion, religion.

There are definite limitations to the data. For a really adequate study of the characteristics of women in WHO'S WHO, and perhaps especially for an adequate study of the family characteristics, one would need much more data than those afforded in the brief biographies. Furthermore, many biographies fail to provide information on all items listed above. The printed sketches are based upon facts supplied by the subjects themselves on standardized questionnaire forms. In a few cases, however, little besides the name of the person is listed, owing to the inability of the editors to locate the person or to secure any return from him or her. In other cases certain items of information such as those regarding year of birth, year of marriage, and previous marriages may not be given simply because of the unwillingness of the person to have such information appear in reference books available to the public.

The extent of such omissions and their probable relevance to the validity of the findings will be discussed as the several items of information are considered. It may be appropriate to state here, however, that despite fairly large proportions of unknowns with respect to certain items, the analysis confirms what is probably already a general consensus of opinion, namely, that persons invited to submit biographical data to WHO'S WHO do not take the task lightly. As far as we could judge from internal consistency and from some cross-checking with other biographies, obituaries, and the known facts with reference to a few of the women in WHO'S WHO, the standards of accuracy are quite high. Although sins of omission are fairly frequent with respect to certain items, sins of commission in the form of misstatement of fact appear to be virtually negligible.

The study relates to 2,409 women in the 1948–1949 edition of

WHO'S WHO. This number includes virtually all that were listed. Only a small number, probably forty to fifty, were not included because their permanent residence appeared to be a foreign country or because they were indicated as having died before the volume was published.

Women comprise only about 6 per cent of all persons listed in the last edition of WHO'S WHO. If the mention of this small proportion has a "red flag" effect on the feminists, we hasten to add that the proportion probably was even smaller in the earliest edition and that it probably will increase in the future. Also, by virtue of the small proportion, the women actually in WHO'S WHO probably have some claim to more distinction than do their male counterparts. Despite the greater odds against them, they made WHO'S WHO.

According to its editors, the aim of WHO'S WHO IN AMERICA is "to include the names, not necessarily of the best, but rather of the best-known, men and women in all lines of useful and reputable achievement."[12] What are the "lines of achievement," i.e., the occupations and fields of distinction of the women so recognized? This question cannot be answered precisely in statistical terms, for many of the women, like many of the men in WHO'S WHO,[13] have engaged in multiple activities. If one had to depend on the chronological listing of occupations in the biographical sketches alone, one frequently would have difficulty in ascertaining the chief claim to fame. Fortunately, however, virtually all of the biographical sketches begin with a designation of the subject's occupation or field of distinction. With certain exceptions these were used as the bases for the present classifications. If more than one was given, the one

[12] Two broad classes of admissions are further described by the editors: (1) the selections on an individual basis, i.e., "persons who have accomplished some conspicuous achievement—something out of the ordinary, so to speak—" and (2) the arbitrary admissions "on account of official position—civil, military, naval, religious, or educational." The two classes are by no means mutually exclusive, however, and the editors state that "the majority in these arbitrary classifications would because of unofficial achievement, be admitted without hesitation irrespective of official position." WHO'S WHO IN AMERICA, Volume 25, p. 8, 1948–1949 edition.

[13] Throughout this paper the use of WHO'S WHO will be understood as a contraction for WHO'S WHO IN AMERICA.

listed first was coded unless the biography itself rather definitely indicated that another more closely represented the occupation or field in which the person had gained distinction.

The chief exception to the above was that professors and public officials were coded as such by occupation and according to their specialties by field of distinction. For instance, a person described as "economist" directly after her name but also described in the biography as being a professor would be coded as a professor by occupation and her broad field of distinction would be coded as social science. A corresponding procedure was used for specialists employed by the government.[14]

Despite the limitations of the data by occupation, the results presented in Table 1 are believed to be at least highly suggestive. Nearly 23 per cent of the women in WHO's WHO are in the field of formal education as college presidents, deans, professors, and "other teachers."[15] Almost the same proportion (22 per cent) are authors (including novelists, poets, playwrights, magazine writers, etc.). Artists constitute 7 per cent, editors, reporters, columnists, etc. 6 per cent, and public officials 6 per cent. The women best described as "club women," i.e., those engaged in state or national committee work in connection with women's clubs, and various types of civic and nonprofessional social welfare work constitute another 6 per cent. Actresses and dancers constitute 5 per cent, musicians and singers 4 per cent, professional welfare workers 4 per cent, political party workers 3 per cent, business women 3 per cent, librarians (excluding deans and professors of library science)

[14] The occupational code used in the present study was, with slight modification, the one used by the United States Bureau of the Census in connection with the 1940 Census. The field of distinction code was developed on the basis of preliminary hand tabulations of entries in WHO's WHO itself.

The classification by field of distinction is used as a supplement to that by occupation only for broad descriptive purposes. It was desired not only because different fields frequently are represented within a given occupation such as teaching, but also because different occupations may be represented in the same broad field such as fine arts.

[15] More specifically, the group consists of 46 classified as college presidents, 105 as college deans (excepting departmental deans), 209 as college professors or teachers (including departmental deans), and 83 as "other teachers." The last-mentioned class is composed mainly of head-mistresses of schools not ranked as colleges.

2 per cent, religious workers 2 per cent, and women in miscellaneous other occupations 8 per cent.

Like the occupational distribution, the related one by broad field of distinction is not claimed to be more than an approximation. As previously indicated, this classification serves mainly to distribute teachers and government workers according to their fields of interest. The most heavily represented broad field is that of "literature, languages, and journalism." It is represented by 28 per cent of the women and includes not only professional authors and journalists but teachers and others distinguished in that field. The broad field of "fine arts" comes next with 17 per cent and is represented mainly by the artists, musicians, singers, actresses, dancers, and teachers of these arts. Education (except teaching) is represented by 16 per cent of the women and includes college presidents and deans

Table 1. Distribution of women in WHO's WHO in 1948, by occupation of distinction.

OCCUPATION	NUMBER	PER CENT
ALL OCCUPATIONS	2,409	99.8
College or School Officials and Teachers	543	22.5
College Officials and Teachers	*460*	*19.1*
Other Teachers (Chiefly Headmistresses)	*83*	*3.4*
Authors	537	22.3
Artists	157	6.5
Editors, Reporters, etc.	152	6.3
Public Officials	148	6.1
Club Women	138	5.7
Actresses and Dancers	110	4.6
Musicians and Singers	102	4.2
Welfare Workers (Professional)	95	3.9
Political Party Committee Women	82	3.4
Business (Proprietors, Managers, and Officials)	63	2.6
Librarians (Except Deans and Teachers of Library Science)	50	2.1
Religious Workers	39	1.6
Lecturers	29	1.2
Physicians and Surgeons	28	1.2
Lawyers and Judges	21	0.9
Professional Workers (not elsewhere classified)	66	2.7
Other Occupations	49	2.0

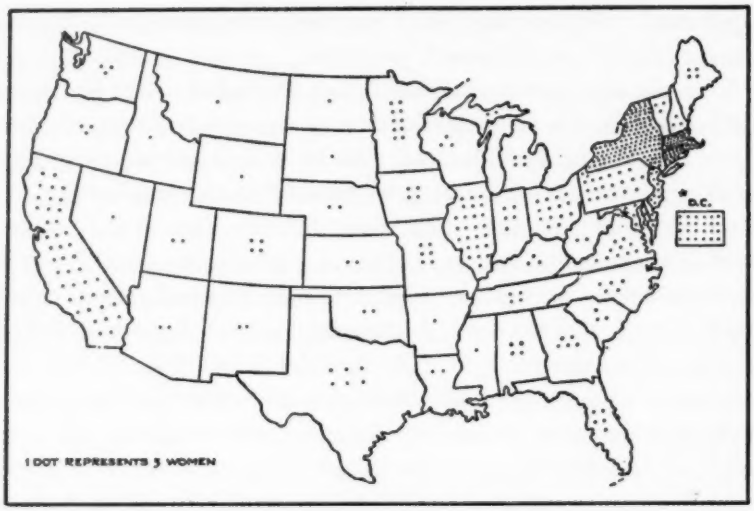

Fig. 1. State of residence of women in WHO'S WHO in 1948.

(except departmental deans), head mistresses, librarians, museum directors, and state commissioners of education. The field of law and politics is represented by 7 per cent, medicine and public health by 7 per cent, social science by 5 per cent, social welfare by 5 per cent, women's club activities (not elsewhere classified) by 5 per cent, business and commerce by 3 per cent, religion by 2 per cent, the "natural" or "pure" sciences by 2 per cent, and miscellaneous other fields by 3 per cent. A comparable distribution of men in WHO'S WHO doubtless would show, among other differences, considerably lower proportions in the fields of literature and the fine arts and considerably higher proportions in business and the natural sciences than those observed for the women.

Residence. Where do the women in WHO'S WHO live? The state of residence was coded for 2,365 living in the United States. Every state is represented as a place of residence but the number extends from only three in each of the States, North Dakota, South Dakota, and Delaware, to 706 in New York. The spot map by place of residence, Figure 1, shows a heavy

concentration in New England, the Middle Atlantic States, the District of Columbia, Illinois, and California. Each of four States (New York, California, Massachusetts, and Illinois) and the District of Columbia was the residence of over 100 women in WHO'S WHO and these places collectively accounted for 58 per cent of all United States women in WHO'S WHO. Five additional States (Pennsylvania, Connecticut, Ohio, Virginia, and New Jersey), each with 50–99 resident women in WHO'S WHO, account for an additional 15 per cent; so that nearly three-fourths (73 per cent) reside in the nine States mentioned above and the District of Columbia.

In terms of number of women in WHO'S WHO per 100,000 white females 35 years of age and over in 1940, the District of Columbia leads by far with 107, and is followed by Nevada with 28, Connecticut with 25, New York with 24, Massachusetts and Vermont with 18 each, and California, New Hampshire, and New Mexico with 15 each (*see* Figure 2). All Southern areas except the District of Columbia, Maryland, and Virginia fall below the national average of 9.9. The ten States ranking lowest with respect to number of women residents in WHO'S WHO per 100,000 white females 35 years of age and over, are Mississippi, West Virginia, Texas, Michigan, North Dakota, South Datoka, Wisconsin, Arkansas, Kansas, and Oklahoma. It should be emphasized, however, that the array of states is subject to a high degree of statistical error. For instance, since Nevada had somewhat fewer than 18,000 white females 35 years of age and over in 1940, her five women in WHO'S WHO yields a rate of 28 per 100,000 and the next-to-highest position. Oklahoma, with eight women in WHO'S WHO, falls in lowest position with 2.1 per 100,000 since the population base is nearly 373,000.

Nevertheless, there is no doubt that, despite the high positions of Maryland, the District of Columbia and near-by Virginia, the South, as well as the North Central States, ranks low as a place of residence of women in WHO'S WHO in relation to its population, even when the index is based upon *white* females

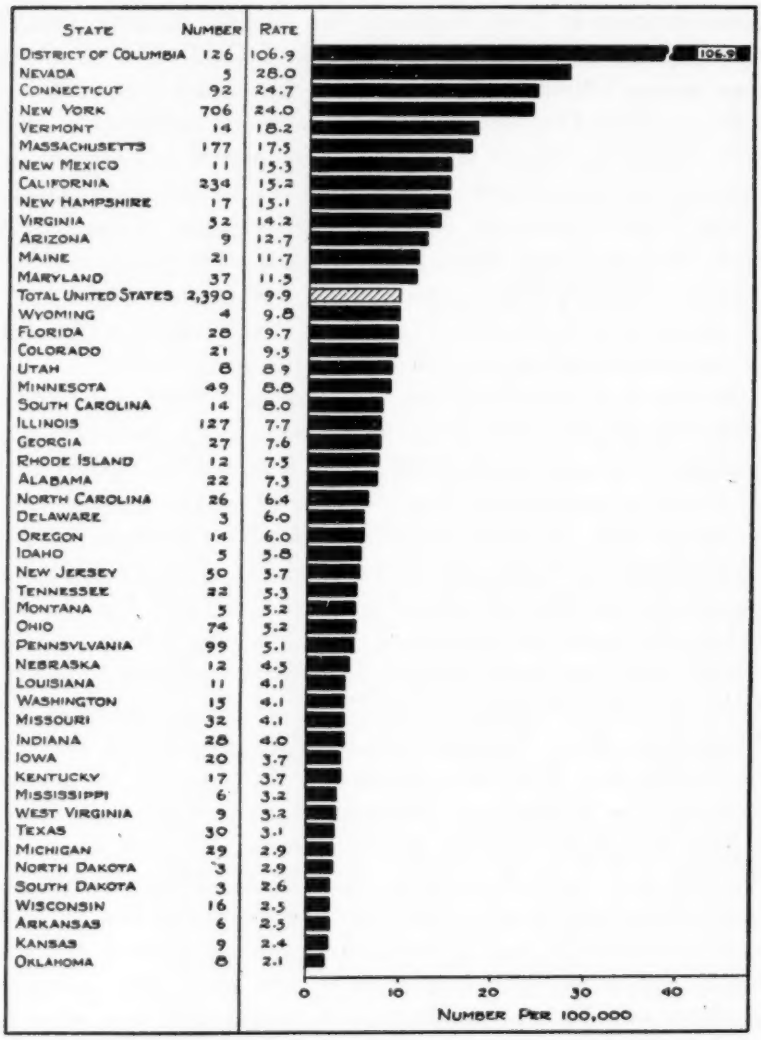

Fig. 2. Array of states according to number of WHO'S WHO women residents in 1948 per 100,000 total white females 35 years of age and over in the State in 1940.

35 years of age and over. The index is 7.9 for the South, as compared with 15.5 for the Northeast, 4.9 for the North Central States, and 11.7 for the West.

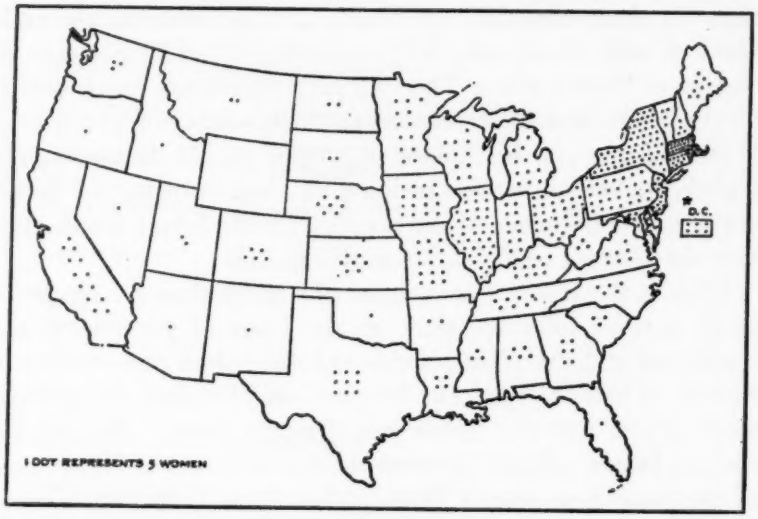

Fig. 3. State of birth of women in WHO's WHO in 1948.

State of Birth. As expected, a much smaller degree of concentration is found in distributions by state of birth than by state of residence. This is pointed up not only in the differences between the spot maps by place of residence and place of birth (Figures 1 and 3), but also in Figure 4 which shows the percentage distribution of women in WHO's WHO by geographic division and broad region of residence and of birth. The distribution by residence includes the 188 foreign-born women in the study (who, incidentally, came mainly from Europe) whereas that by state of birth is based on the 2,195 natives reporting state of birth. This slight difference in bases, however, does not vitiate the generalization that concentration by place of birth is much less marked than that by place of residence. Thus, whereas the Middle Atlantic States were the residences of 36 per cent of the women in WHO's WHO, they were the birthplaces of only 24 per cent. The whole Northeast (Middle Atlantic and New England combined) was the residence of half of the women in WHO's WHO, but the birthplace of only 38 per cent. Likewise, the West (Mountain and Pacific combined) was the residence of 14 per cent but birthplace of only 7 per

cent. In sharp contrast, the North Central area was the residence of only 17 per cent but the birthplace of 38 per cent of women in WHO's WHO. The two proportions are much nearer for the South as a whole, for it was the residence of 19 per cent of the women and birthplace of 18 per cent.[16] However, the slightly higher proportion residing in, than born in, the South is due to the influence of the South Atlantic States which contain the District of Columbia and Virginia.

Despite the lower concentration by birth than by residence there is some evidence that on the basis of population the Northeast and the West contributed more than their quotas of women in WHO's WHO, the North Central region its approximate quota, and the South less than its quota. The Northeastern States collectively were the native states of 38 per cent of the women in WHO's WHO, although in 1890 (the Census year nearest the 1891 median year of birth), these states contained only 30 per cent of the native-white females in the United States. The North Central States also contributed 38 per cent of the women in WHO's WHO, but had 39 per cent of the native-white female population. The South contributed only 18 per cent of the WHO's WHO women although that region contained 27 per cent of the native-white female population in 1890. The West contributed 7 per cent with only 4 per cent of the population.

Stated in another manner, the number of WHO's WHO women

[16] Percentage distributions by region of birth are given below for three groups for purposes of comparison:

Region of Birth (Natives of United States)	2,195 Women in WHO'S WHO (1948)	20,232 Persons in WHO'S WHO (1922)[1]	2,257 Starred Scientists in AMERICAN MEN OF SCIENCE (1901–1943)[2]
North East	38.0	43.6	47
North Central	37.5	34.4	39
South	17.7	19.1	10
West	6.7	2.8	4

[1] From Visher (1931) *op. cit.*, pp. 736–737.
[2] From Visher (1947) *op. cit.*, p. 39.

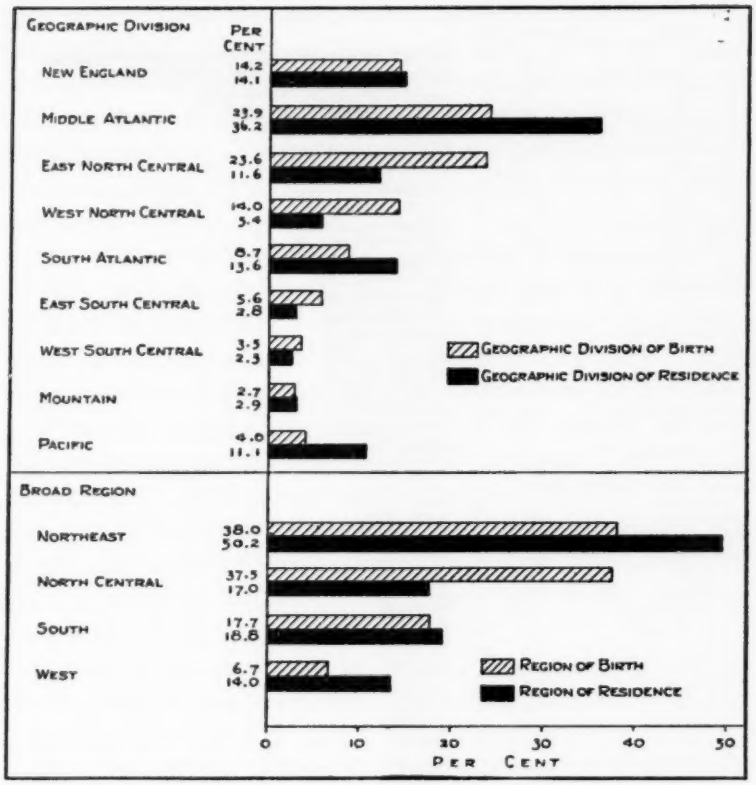

Fig. 4. Percentage distribution of women in WHO's WHO in 1948 by geographic division and by broad region of birth and residence.

born in given regions per 100,000 native-white females in those regions in 1890 was 12.5 for the Northeast, 9.4 for North Central States, 6.3 for the South, and 15.0 for the West. It is recognized, however, that these comparisons are to some extent invalidated by regional differences in recent population growth and age of women in WHO's WHO. For instance, the high position of the West may be due in part not only to relatively rapid increase of population in that area during the past few decades, but also to the relative recency of Hollywood as a place for gaining WHO's WHO recognition.

When individual states are listed in order by number of

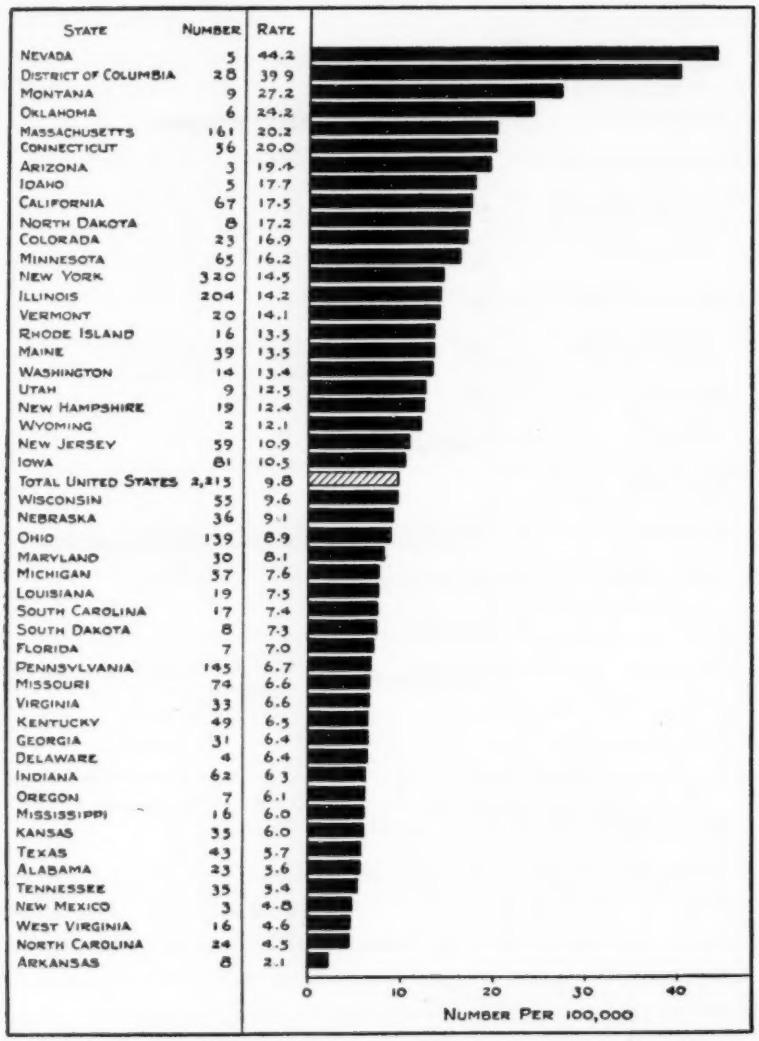

Fig. 5. Array of states according to number of native daughters in the 1948 Who's Who per 100,000 native-white females in the State in 1890.

native women in Who's Who per 100,000 native-white females in 1890, Nevada ranks at the top with a rate of 44 (*see* Figure 5). As before, this is a somewhat accidental result since only five Who's Who women reported Nevada as their state of

birth. For this same reason other states have more or less accidentally high or low positions in the array. Nevertheless, it is of interest to note that the six top positions are held by Nevada, the District of Columbia, Montana, Oklahoma, Massachusetts, and Connecticut. The six lowest positions are held by Alabama, Tennessee, New Mexico, West Virginia, North Carolina, and Arkansas.

The differences between the distribution of women in WHO'S WHO by residence and nativity, of course, are due to migration. Much of this migration is toward the Northeast. Thus, among WHO'S WHO women born in the South, only 59 per cent are still residing there; 27 per cent reported residence in the Northeast, 7 per cent in North Central States, and 7 per cent in the West. Among natives of the North Central States only 41 per cent are still there, 31 per cent are in the Northeast, 14 per cent in the South and 14 per cent in the West. Among natives of the West, 56 per cent reported residence in that area in 1948, 33 per cent had migrated to the Northeast, 4 per cent to North Central States, and 7 per cent to the South.

The question may also be asked, what proportion of the WHO'S WHO women residing in a given region are natives of the same region? The data regarding this question are again restricted to natives of the United States. This proportion is highest (84 per cent) for residents of the North Central States despite the fact that migration away from that area was also heaviest. Nearly two-thirds (62 per cent) of the WHO'S WHO women in the Northeast were born there, about one-fourth (24 per cent) were born in the North Central States, and the remainder in the South and West. Among WHO'S WHO residents of the South, 53 per cent were born there, 44 per cent were born in the North, and the remainder in the West. Among the WHO'S WHO women in the West only slightly more than one-fourth (27 per cent) were natives of that region. Thirty-nine per cent came from North Central States, 24 per cent from the Northeast, and 10 per cent from the South.

Type of Community of Residence and Birth. Despite certain

limitations of the data by type or city size of the community of residence and birth, several generalizations can be made. In the first place, the women in WHO'S WHO in 1948 were more heavily concentrated in large cities than was the general population in 1940. Over half (53 per cent) of the women in WHO'S WHO as compared with only 29 per cent of the total population resided in cities of 100,000 population or over. Only about 12 per cent of the women in WHO'S WHO as compared with 43 per cent of the total population lived in rural areas or in villages under 2,500 population.[17] The proportions in places of 2,500–100,000 were not greatly different, 35 per cent for women in WHO'S WHO and 28 per cent for the general population.

One sometimes hears that disproportionately large numbers of people in WHO'S WHO were born in rural areas and small towns. In so far as the women are concerned, it is true that the proportion born in such places is larger than the proportion residing in such places in 1948. Thus, whereas about one-third (32 per cent) were born in communities under 2,500 population, only about 12 per cent were residing in communities of this size in 1948. Cities of 100,000 and over were the birthplaces of 30 per cent of the women but the 1948 residences of 53 per cent. Differences of this type, of course, accrue partly from rural-urban migration and general urbanization of the population through growth of cities.

One would like to know, however, the relative importance of different types of communities as places of birth of women in WHO'S WHO in relation to the total number of births or population in such areas. The data afforded in Table 2 for this type of comparison are necessarily crude. The classification of women in WHO'S WHO by type of native community is based on size of the community at the time of birth of each person. Since the birth dates of the women extend from 1851 to 1937, it is impossible to secure accurate population bases. Approximate

[17] It should be stated, however, that it was not always clear whether the reported home address was the actual residence or the mail address. In consequence, the proportion of WHO'S WHO women classified as living in rural areas (under 2,500) may be somewhat low.

bases, however, are afforded by the population in cities of different sizes in 1890, the nearest Census to the 1891 median year of birth of women in WHO's WHO. In the first place it will be noted that whereas approximately two-thirds of the population of 1890 was rural or in places of under 2,500, only about one-third of the WHO's WHO women were born in such areas. In other words, about two-thirds of the WHO's WHO women reported urban areas as birthplaces although only one-third of of the 1890 population was urban.

The indices in the last column of Table 2 relate to number of women in WHO's WHO born in communities of given size, per 100,00 persons living in communities of the same size in 1890. This index is much lower for the rural than for the urban population, 1.7 as compared with 6.7. Within the urban areas themselves there is no marked difference by size of city. Actually, the index is 7.6 for towns between 2,500 and 10,000 and it declines slightly but consistently to 5.4 for cities of 100,000–

Table 2. Type of community in which women in WHO's WHO in 1948 were born in relation to residence of the 1890 population of the United States.

TYPE OR SIZE OF COMMUNITY	BIRTHPLACE OF "WHO'S WHO" WOMEN (Born in U.S.)		RESIDENCE OF UNITED STATES POPULATION IN 1890[1]		NUMBER OF "WHO'S WHO" WOMEN PER 100,000 POPULATION OF 1890
	Number	Per Cent	Number	Per Cent	
TOTAL	2,180	100.0	62,947,714	100.0	3.5
Rural (Under 2,500)	705	32.3	40,841,449	64.9	1.7
Urban (Total)	1,475	67.7	22,106,265	35.1	6.7
2,500– 9,999	353	16.2	4,660,692	7.4	7.6
10,000– 49,999	351	16.1	5,720,044	9.1	6.1
50,000– 99,999	119	5.5	2,027,569	3.2	5.9
100,000–499,999	284	13.0	5,229,502	8.3	5.4
500,000–999,999	64	2.9	806,343	1.3	7.9
1,000,000–and Over	304	13.9	3,662,115	5.8	8.3

[1] Sixteenth Census of the United States: POPULATION, Vol. I, Government Printing Office, Washington, 1942, p. 26.

500,000 but increases again to 7.9 for cities of 500,000–1,000,000 and to 8.3 for cities of 1,000,000 and over.[18]

Religion. Religion could be ascertained for only 1,097 of the women in WHO'S WHO, about 46 per cent of the total. This includes a few cases for which religion was not explicitly reported but was readily identifiable by the occupation or affiliation. Of those for whom religion was coded, nearly 87 per cent were Protestant, 11 per cent Catholic, and 3 per cent Jewish. Although the Protestants may be somewhat more heavily represented in relation to the population, the above distribution does not depart far from a distribution for the total population based upon data published in the WORLD ALMANAC for 1949. According to these data, approximately 78 per cent of the United States population in 1948 was Protestant, 18 per cent Catholic, and 4 per cent Jewish. Among the Protestants reporting religion in WHO'S WHO, Episcopalians were most numerous and these were followed, in order, by Congregationalists, Presbyterians, and Methodists.

Age. As a group, the women in WHO'S WHO, are relatively old. The year of birth was stated for 1,791 or 74 per cent of the women. Among these the median year of birth, as previously indicated, was 1891, which is equivalent to a median age of about 57 in 1948.[19] The median age is increased by a half year by the addition of 323 cases for whom age was estimated, chiefly on the basis of year of completing high school or college.[20]

[18] On the basis of "special request" information from 18,400 *persons* in the 1922-1923 edition of WHO'S WHO, Visher found that "approximately equal numbers were born on farms (25.9 per cent) in villages and towns (24.5 per cent) in small cities (24.9 per cent) and in large cities or their suburbs (24.7 per cent)." He further states: "At the 1870 Census, the census nearest to the birth of most of these notables, almost one-tenth of the people of the United States lived in cities of over 50,000; one-ninth in cities of 8,000 to 50,000; one-twelfth in small places; and almost seven-tenths on farms." Visher (1947) *op. cit.*, pp. 60–61.

[19] The median age was slightly lower, 55, for women reporting year of birth in the 1926–1927 edition of WHO'S WHO. Approximately 13 per cent of those women were under 40 and two-thirds had passed 50. *See* Cope, *op. cit.*, pp. 221–222.

[20] In these cases, ages at graduation were assumed to be 18 and 22 for high school and college, respectively. These assumptions are based upon a sample tabulation of WHO'S WHO women reporting year of birth and year of graduation from high school or college.

As indicated in Table 3 and Figure 6, the estimated ages run a little higher than the ages computed from year-of-birth reports. The median age for the group of 323 is about 60 as compared with 57. This difference may be a real one in that women failing to report their year of birth may tend to be older than those giving such report, except, perhaps, as the data suggest, at oldest ages when one's age may be a matter of pride. Whatever the situation may be, inclusion of the estimated with reported ages has only minor effect on the age distribution based upon actual reports. On the basis of the reported plus estimated ages, only 1 per cent of the women in WHO's WHO were under 30, only 7 per cent were under 40, and 15 per cent

Table 3. Percentage age distribution of women in WHO's WHO in 1948. Data relate to 1,791 women reporting year of birth, and 323 for whom ages were estimated.

AGE	TOTAL	YEAR OF BIRTH REPORTED	AGE ESTIMATED[1]	TOTAL	YEAR OF BIRTH REPORTED	AGE ESTIMATED[1]
	Number			Per Cent		
TOTAL	2,114*	1,791	323	100.0	100.1	99.9
10–14	1	1	—	0.1	0.1	—
15–19	1	1	—			
20–24	3	3	—	0.1	0.2	—
25–29	18	17	1	0.9	1.0	0.3
30–34	43	40	3	2.0	2.2	0.9
35–39	77	73	4	3.6	4.1	1.2
40–44	177	158	19	8.4	8.8	5.9
45–49	263	225	38	12.4	12.6	11.8
50–54	318	272	46	15.0	15.2	14.2
55–59	314	268	46	14.9	15.0	14.2
60–64	296	237	59	14.0	13.2	18.3
65–69	243	201	42	11.5	11.2	13.0
70–74	164	126	38	7.8	7.0	11.8
75–79	107	93	14	5.1	5.2	4.3
80–84	59	50	9	2.8	2.8	2.8
85–89	19	16	3	0.9	0.9	0.9
90–94	10	9	1	0.5	0.6	0.3
95–99	1	1	—			

* Excludes 295 women classified as "age unknown."
[1] Age estimated on basis of reported year of completing high school or college.

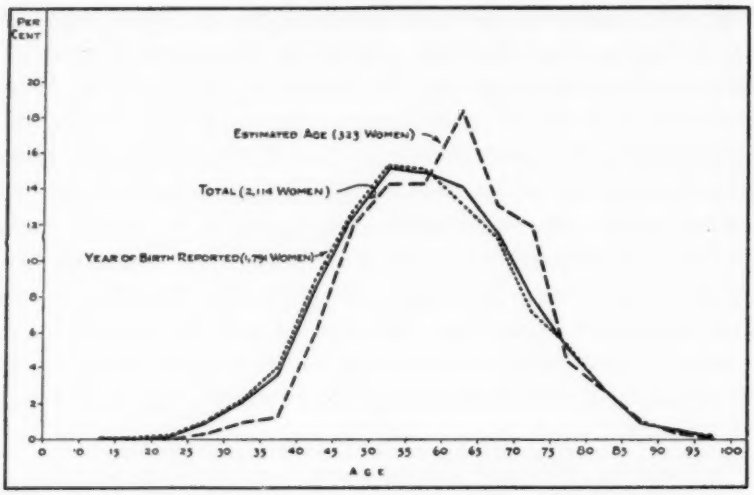

Fig. 6. Percentage age distribution of women in WHO's WHO in 1948. Data relate to 1,791 women reporting year of birth and 323 for whom age was estimated. Excludes 295 women classified as age unknown. *See* Table 3.

under 45. Over half (56 per cent) were 45–64, and over one-fourth (29 per cent) were 65 and over. Among those 65 years of age and over, of course, are many who are no longer active. It would be of interest to investigate age at first admission to WHO's WHO but no attempt at this was made in the present study.

Educational Attainment. As would be expected, the women in WHO's WHO outrank by far the general female population with respect to educational attainment. Among 2,333 women supplying information on education, nearly three-fourths (72 per cent) reported at least some college attendance. Only about 10 per cent of the women of approximately comparable age (25 years of age and over) in the United States reported any college attendance in the 1940 Census. (Table 4.) The proportion of women in the last edition of WHO's WHO reporting college attendance apparently was considerably higher than that for women in the 1926–1927 edition (54 per cent)[21] but

[21] According to Cope, among women in the 1926–1927 edition of WHO's WHO only about 54 per cent reported college attendance, 27 per cent attendance in "public

(Continued on page 411)

somewhat lower than that for men in the most recent edition (89 per cent).[22]

Only five of the women in WHO'S WHO (only 0.2 per cent) were coded as definitely below high school level. Seven per cent reported one or more years in high school but no further education. Ten per cent simply reported themselves as graduates or attendants of "special" schools or conservatories (music, art, dramatics, etc.), and 11 per cent reported only "private" educa-

Table 4. Educational attainment of women in WHO'S WHO in 1948 and of women 25 years of age and over in the 1940 Census.[1]

EDUCATIONAL ATTAINMENT	"WHO'S WHO" WOMEN		WOMEN 25 YEARS OF AGE AND OVER IN UNITED STATES CENSUS IN 1940
	Number	Per Cent[2]	Per Cent[2]
TOTAL	2,409	99.9	100.1
College 4 or More	1,287	55.2	3.8
Doctor's Degree	*422*	*18.1*	—
Master's Degree	*289*	*12.4*	—
Bachelor's Degree	*576*	*24.7*	—
College 1–3	393	16.8	6.1
High School 1–4	168	7.2	32.3
Below High School	5	0.2	57.9
"Special" (Only Report)	227	9.7	—
"Private" (Only Report)	253	10.8	—
Unknown Education	76	—	—

[1] The 1940 Census data are from Sixteenth Census of the United States 1940: POPULATION, Vol. II, Part I, p. 11.
[2] Percentages based upon numbers reporting on educational attainment.

or private" schools, and 19 per cent in "special schools." Cope supplies no data by academic degree. *See* Cope, *op. cit.*, p. 220.

[22] The men in WHO'S WHO apparently tend to have more formal education than women. In the preface of the 1948–1949 edition, distributions by educational attainment are provided for (a) persons in the 1946–1947 edition and (b) new additions in the 1948–1949 edition. The subtraction of the present data for women from the sum of the (a) and (b) distributions affords an approximate but not exact distribution of the men by educational attainment. According to this computation nearly 28 per cent of the men held the doctor's degree, 13 per cent the master's, and 37 per cent the bachelor's degree. A total of 77 per cent were college graduates and an additional 12 per cent attended college 1–3 years. Two per cent reported "special" education and 9 per cent were "other noncollege."

tion. Over one-half (55 per cent) of the women reporting on education in WHO's WHO held college degrees. By highest degree, 18 per cent had the doctorate, 12 per cent the master's degree, and 25 per cent the bachelor's degree.

As indicated in Table 5, the educational attainment of WHO's WHO women differs widely by occupation. The highest educational attainment was reported by the group of college presidents, deans, and professors. Approximately 96 per cent of these were college graduates; 58 per cent reported a doctor's degree; nearly 25 per cent a master's degree; and 13 per cent a bachelor's degree. The proportion reporting a college degree was 82 per cent for teachers other than college professors, 70 per cent for librarians, 68 per cent for women in government service, 62 per cent for welfare workers, 51 per cent for editors and reporters, 47 per cent for club women, 44 per cent for authors, 37 per cent for business women, and 33 per cent for political

Table 5. Educational attainment of WHO's WHO women in 1948 in selected occupations.

OCCUPATION	NUMBER WOMEN[1]	PERCENTAGE DISTRIBUTION BY EDUCATIONAL ATTAINMENT								
		Total	Doctor's Degree	Master's Degree	Bachelor's Degree	College 1–3	High School 1–4	Under High School	Special	Private
TOTAL	2,333	99.9	18.1	12.4	24.7	16.8	7.2	0.2	9.7	10.8
College Officials and Teachers	460	100.0	58.3	24.6	13.3	1.5	0.6	—	1.5	0.2
Other Teachers	82	100.0	13.4	36.6	31.7	13.5	2.4	—	1.2	1.2
Librarians	50	100.0	—	20.0	50.0	18.0	6.0	—	2.0	4.0
Public Officials	145	100.0	22.8	12.4	32.4	18.7	4.8	—	4.1	4.8
Welfare Workers	92	100.1	13.0	20.7	28.3	21.7	3.3	—	2.2	10.9
Editors, Reporters, etc.	148	100.0	2.7	8.8	39.9	25.6	6.8	—	2.7	13.5
Club Women	133	100.0	2.3	8.3	36.8	21.0	4.5	—	3.0	24.1
Authors	514	99.9	3.9	7.2	32.7	24.7	8.1	0.6	5.4	17.3
Business Women	57	100.1	1.8	7.0	28.1	24.6	12.3	—	12.3	14.0
Political Party Committee Women	77	100.1	1.3	5.2	26.0	27.3	18.2	—	2.6	19.5
Musicians and Singers	99	99.9	1.0	—	11.1	12.1	18.1	1.0	49.5	7.1
Artists	155	100.0	—	0.6	10.3	13.6	15.5	—	55.5	4.5
Actresses and Dancers	94	100.0	—	2.1	2.1	18.1	18.1	1.1	17.0	41.5
Other Occupations	227	100.1	30.0	11.9	22.0	18.1	5.3	—	6.2	6.6

[1] Numbers relate to women reporting on educational attainment. Data not shown for specific occupational groups with fewer than 50 women.

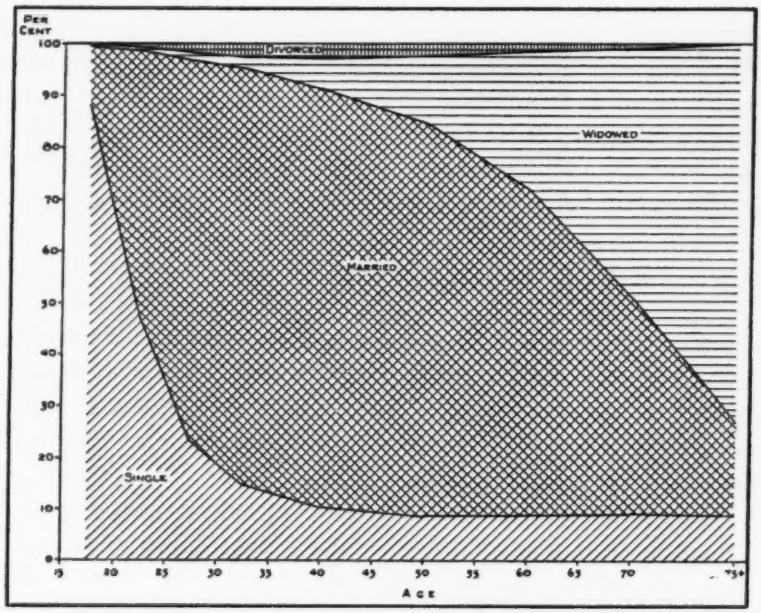

Fig. 7. Marital status by age for women 15 and over in the United States: 1940 Census. *See* Table 6.

party workers. In sharp contrast, it was 12 per cent for musicians, 11 per cent for artists, and 4 per cent for actresses and dancers. However, 55 per cent of the artists and 49 per cent of the musicians and singers reported "special" training, and 41 per cent of the actresses and dancers reported "private" schooling.[23]

Marital Status. Women in WHO's WHO also differ sharply from the total female population with respect to marital status. Despite their relatively old age, 40 per cent of the WHO's WHO women were classified as never married, 47 per cent as married, 10 per cent as widowed, and 4 per cent as divorced. Figures 7

[23] Cope's data for 946 women reporting type of school attended in the 1926–1927 edition of WHO's WHO revealed essentially similar occupational differentials. The proportions reporting college attendance ranged from 12 per cent for the consolidated group of musicians, painters, actresses, and sculptors (labeled by Cope as "artists") to 91 per cent for the "educators." It was 65 per cent for "social workers" (professional and nonprofessional combined), 66 per cent for a consolidated "professional" group (editors and journalists, librarians, physicians, lawyers, and miscellaneous), and 72 per cent for a consolidated group of "authorities" (scientists, home economists, sociologists, and historians). *See* Cope, *op. cit.*, p. 220.

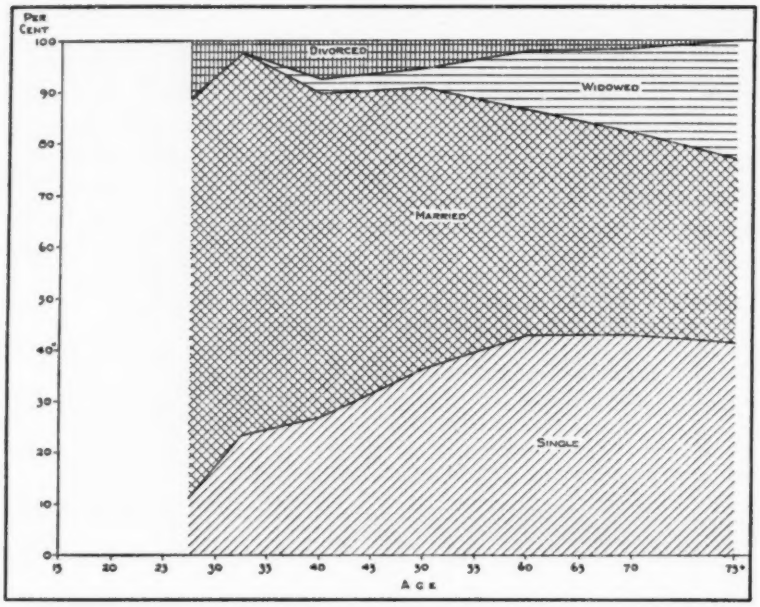

Fig. 8. Marital status by age for women 25 and over in WHO's WHO in 1948. *See* Table 6.

and 8, present, respectively, the percentage distribution by marital status at successive ages among all women 15 years of age and over in the 1940 Census and among women 25 years of age and over in WHO's WHO for 1948. (See also Table 6.) The difference in proportions single is striking, especially among the older women. For example, whereas 43 per cent of the WHO's WHO women 55–64 are single, only 9 per cent of the total female population of that age group have never married. Attention is also called to the fact that whereas the proportion single in the total female population declines rather sharply with advancing age until it reaches a level of about 9 per cent after age 45, the proportion single among WHO's WHO women rises sharply with age until it reaches a level of about 43 per cent after age 55. In other words, higher proportions of the younger than of the older women in WHO's WHO are married. This may be due partly to less restriction than formerly on the types of careers

available to women and to less restriction on the type of accomplishments recognized in WHO's WHO. It probably also reflects increasing tendencies for women to combine marriage with a career. Only 53 per cent of the women in Cope's[24] sample of 1,000 from the 1926–1927 edition of WHO's WHO were classified as ever married, as compared with 60 per cent in the present study. Other studies have indicated a pronounced increase over the past fifty years in the proportions of female college graduates who marry.[25]

Neverthless, there is still a far greater incompatibility of marriage and career among women than among men in WHO's WHO. Available data indicate that although men in WHO's WHO tend to marry later than do males in the general population, the proportion eventually marrying is fully as high and perhaps a little higher than that in the general population.[26]

The somewhat lower proportion of widows among WHO's WHO women than among all females of comparable age is in part a function of lower proportions ever married. On the other hand, the proportion of WHO's WHO women reporting themselves as currently divorced, is higher than that for all females, especially at ages under 55.

A word may be said about the general validity of the classification by marital status. Only about one-fourth of the WHO's WHO women classified as single in this study were explicitly designated "unmarried" in the biographies. The remainder, however, were women listed under their maiden names and for

[24] According to Cope's analysis 53.1 per cent were "married," 42.0 per cent were "married—husbands living," and 11.1 per cent were "widowed." The last category presumably includes those divorced. *See* Cope, *op. cit.*, p. 213.

[25] Thus among 151 Vassar graduates of the classes of 1872–1876 who answered questionnaires about themselves in 1919 when their average age was about 67, only 56 per cent had married. In contrast, among 951 graduates of the classes of 1912–1916 reporting in 1929 when their average age was about 37, approximately 73 per cent had married. From studies by (a) Mabel Newcomber and Evelyn S. Gibson and (b) Mabel Newcomber as reported in Lorimer, F. and Osborn F.: THE DYNAMICS OF POPULATION. New York, The Macmillan Company, 1934, pp. 321 and 324.

[26] An analysis of the first 8,750 men listed in the 1926–1927 edition of WHO's WHO led Huntington and Whitney to conclude that "by the time they reach the age of 55 years, at least 91 per cent of the men in WHO's WHO will be married." Huntington and Whitney, *op. cit.*, p. 158.

whom no marriage was mentioned. This procedure may have resulted in too many being classified as single but it seems doubtful that this bias is large. The women classified as "widowed" are restricted to cases in which the word "deceased" or its equivalent appeared after the name of the husband, or last husband if more than one marriage was listed. Likewise, the "divorced" group is restricted to cases described as "divorced," "marriage dissolved," or "marriage annulled" in the biographies. Thus, the numbers classified as widowed or divorced may be too low as a result of failure of the subjects to supply information on these points. In general, however, it is

Table 6. Marital status by age for WHO's WHO women of 1948 and for females 15 years of age and over in the United States in 1940.

AGE	NUMBER WOMEN	TOTAL	SINGLE	MARRIED	WIDOWED	DIVORCED
		WOMEN IN "WHO'S WHO"				
TOTAL	2,407*	100.0	40.3	46.5	9.6	3.6
Under 20	2					
20–24	3					
25–29	18	99.9	11.1	77.7	—	11.1
30–34	43	100.0	23.3	74.4	—	2.3
35–44	254	100.1	26.8	63.0	2.4	7.9
45–54	580	100.0	36.2	54.5	3.8	5.5
55–64	610	100.0	42.6	43.8	11.5	2.1
65–74	406	100.0	42.9	38.9	16.3	2.0
75+	196	100.0	41.3	35.7	23.0	—
		WOMEN IN UNITED STATES CENSUS: 1940[1]				
TOTAL	49,361,562	100.0	25.8	61.0	11.5	1.7
15–19	6,153,370	99.9	88.1	11.6	0.1	0.1
20–24	5,895,443	100.0	47.2	51.3	0.6	0.9
25–29	5,645,976	100.0	22.8	74.1	1.3	1.8
30–34	5,172,076	100.0	14.7	80.4	2.5	2.4
35–44	9,168,426	100.0	10.4	81.0	5.9	2.7
45–54	7,550,052	100.0	8.7	76.0	13.1	2.2
55–64	5,163,025	100.0	9.0	63.0	26.4	1.6
65–74	3,209,134	100.0	9.4	41.6	48.1	0.9
75+	1,404,060	100.1	9.0	17.8	72.9	0.4

* Excludes two women for whom marital status was not coded.

[1] Sixteenth Census of the United States, 1940: POPULATION, Vol. IV, CHARACTERISTICS BY AGE, Part I, UNITED STATES SUMMARY, Government Printing Office, Washington, D. C. 1943, p. 5.

believed that the distributions by marital status are substantially in accord with the facts.

As indicated in Table 7 and Figure 9, marital status differs sharply by educational attainment and occupation. By education, the highest proportions of unmarried women are found among the holders of master's and doctor's degrees. Approxi-

Table 7. Marital status of women in WHO'S WHO in 1948, by educational attainment and by occupation.

EDUCATION AND OCCUPATION	ALL WOMEN					EVER-MARRIED WOMEN				
	Number Women	Percentage Distribution by Marital Status				Number Women	Percentage Distribution by Marital Status			
		Total	Single	Married	Widowed	Divorced		Total	Married	Widowed	Divorced
ALL CLASSES	2,407[1]	100.0	40.3	46.5	9.6	3.6	1,437	100.0	77.9	16.1	6.0
By Education											
Doctor's Degree	422	99.9	63.0	30.3	5.7	0.9	156	100.1	82.1	15.4	2.6
Master's Degree	288	100.0	65.6	24.0	7.6	2.8	99	100.0	69.7	22.2	8.1
Bachelor's Degree	576	100.0	38.4	50.3	8.7	2.6	355	100.0	81.7	14.1	4.2
College 1–3	393	100.0	25.7	56.5	12.5	5.3	292	100.0	76.0	16.8	7.2
High School 1–4	168	100.0	24.4	58.3	13.7	3.6	127	100.0	77.2	18.1	4.7
Below High School	5	*					3	*			
"Special"	227	99.9	39.6	49.8	4.8	5.7	137	100.0	82.5	8.0	9.5
"Private"	253	100.0	17.4	60.5	15.8	6.3	209	100.0	73.2	19.1	7.7
Unknown Education	75	100.0	21.3	60.0	14.7	4.0	59	100.0	76.3	18.6	5.1
By Occupation											
Librarians	50	100.0	86.0	10.0	4.0	—	7	*			
College Officials and Teachers	460	100.0	76.3	17.6	5.4	0.7	109	100.0	74.3	22.9	2.8
Other Teachers	83	100.0	68.7	27.7	2.4	1.2	26	100.0	88.5	7.7	3.8
Public Officials	148	100.0	53.4	30.4	15.5	0.7	69	99.9	65.2	33.3	1.4
Artists	157	99.9	42.0	51.6	5.7	0.6	91	100.0	89.0	9.9	1.1
Editors, Reporters, etc.	152	100.0	34.9	46.7	11.2	7.2	99	100.0	71.7	17.2	11.1
Musicians and Singers	102	100.0	34.3	52.9	5.9	6.9	67	100.0	80.6	9.0	10.4
Business Women	63	100.0	31.7	41.3	22.2	4.8	43	100.1	60.5	32.6	7.0
Welfare Workers	95	100.1	28.4	61.1	9.5	1.1	68	100.0	85.3	13.2	1.5
Authors	536	100.0	20.5	62.9	10.1	6.5	426	100.0	79.1	12.7	8.2
Actresses and Dancers	110	100.0	13.6	72.7	0.9	12.7	95	100.0	84.2	1.1	14.7
Club Women	138	100.0	11.6	65.9	20.3	2.2	122	100.1	74.6	23.0	2.5
Political Party Committee Women	82	100.0	4.9	80.5	14.6	—	78	100.0	84.6	15.4	—
Other Occupations	231	100.1	40.7	44.2	12.6	2.6	137	100.1	74.5	21.2	4.4

[1] Excludes two women for whom marital status was not coded. Data not shown for specific occupational groups with fewer than fifty women.
* Percentages not computed.

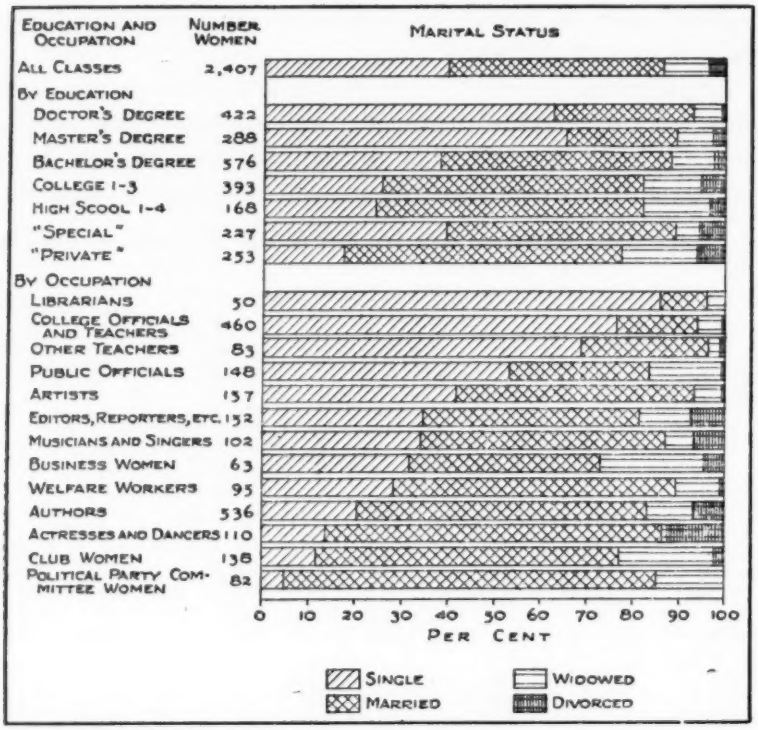

Fig. 9. Marital status of women in Who's Who, by education and occupation. *See* left sections of Table 7.

mately 66 per cent of the former and 63 per cent of the latter were unmarried. The proportion classified as single was about 38 per cent for holders of the bachelor's degree, 26 per cent for those with one to three years of college, and 24 per cent for those mentioning high school training only. About 40 per cent of those classified as "special training," chiefly in music and art schools, were unmarried and 17 per cent of those mentioning only private instruction were single.[27]

[27] The variations in marital status by educational attainment appear to be much less among men than among women in Who's Who. Among men in the 1926–1927 edition studied by Huntington and Whitney, the proportion reporting themselves as ever-married extended from 84 per cent for those classified as "professional school only" to 96 per cent for those reporting attendance in "normal, business and secretarial schools." Unlike the data for women, those for men suggested some positive

(Continued on page 419)

The differences in marital status by occupation are also interesting. Marriage appears to be least prevalent among the librarians; of these 86 per cent are classified as never married. Closely behind, however, are the college officials and teachers, 76 per cent of whom are single. Over two-thirds (69 per cent) of the other teachers are unmarried and so are over half (53 per cent) of the public officials. Approximately 42 per cent of the artists and 34 per cent of the musicians and singers fall into the unmarried class. The proportion of spinsters was lowest (5 per cent) among the political party committee women and next lowest (12 per cent) among the club women. It was also relatively low (14 per cent) for the actresses and dancers.

Although only about one-tenth of all women in WHO'S WHO are classified as widowed, about 22 per cent of the business women and 20 per cent of the club women are so classified. It may be that many of the business women took over their deceased husband's enterprises. In contrast, only about 1 per cent of the actresses and dancers are widows. The relatively young age of women in this group may be one factor, and frequency of remarriage another.

Widowhood and Divorce Among Ever-Married Women. Among the ever-married women in the study about 78 per cent are classified as currently married (at the time of their reports), 16 per cent as widowed, and 6 per cent divorced. (*See* section at the right, Table 7.) By education the proportion widowed among the ever-married extends from 8 per cent for those reporting "special" training only to 22 per cent for holders of the master's degree. The range is wider by occupation, extending from only 1 per cent for the actresses and dancers to 33 per cent for the business women and also for the public officials. The percentage widowed among club women and college

association of educational attainment and proportion ever married. Thus the proportion ever married was 88 per cent for men limited to "elementary and home education," 90 per cent for those of "high school" status, 91 per cent for those of "college" attainment, and 93 per cent for those having the doctor's degree. Huntington and Whitney, *op. cit.*, p. 161.

officials and teachers is also relatively high—about 23 per cent in each case.

Among all ever-married women in WHO's WHO 6 per cent were classified as divorced. By education, the range extended from 3 per cent for those with the doctor's degree to nearly 10 per cent for those reporting "special" education. Aside from this, however, there is little in the way of a consistent relation between education and proportions of ever-married women who are currently divorced.

By occupation the range in proportion of ever-married women reporting themselves as currently divorced extended from none at all for the political party workers, to 15 per cent for the actresses and dancers. Other occupational groups with low proportions of ever-married women currently divorced were public officials and artists (1 per cent), welfare workers (2 per cent), club women and college officials and teachers (3 per cent), and other teachers (4 per cent). Relatively high rates were found for authors (8 per cent), musicians and singers (10 per cent), and editors, reporters, etc. (11 per cent).

Age at Marriage. Not only are women in WHO's WHO less given to marriage that others, but those who do marry do so at later ages. The median age at first marriage for ever-married women in WHO's WHO is 25.4. The median age at marriage for women 15–74 years of age in the 1940 Census[28] (married once—husband present) is 21.7 or 3.7 years below that for the WHO's WHO women. Part of this difference, however, is due to the older age of women in WHO's WHO. The differences are reduced in age-for-age comparisons. It may be noted that the *average* age at first marriage (27.0) computed for women in the last edition of WHO's WHO is almost precisely the same as that (27.1) reported by Cope in the 1926–1927 edition.[29]

[28] Derived from Sixteenth Census of the United States, 1940: POPULATION-DIFFERENTIAL FERTILITY 1940 AND 1910. FERTILITY BY STATES AND LARGE CITIES. Washington, Government Printing Office, 1943, p. 239. Note: Since computation indicated that the published median (21.2) related to median age at last birthday at the time of marriage a half-year was added in the interest of comparability with medians computed for WHO's WHO women.

[29] Cope, *op. cit.*, p. 215.

As would be expected, age at marriage among women in WHO'S WHO differs considerably by educational attainment (*See* Table 8). The median age at first marriage is 29.7 for ever-married women with the doctorate, 28.3 for those with the master's degree, and 26.4 for those with the bachelorate. It is 24.7 for those with one to three years of college, 24.2 for

Table 8. Age at first marriage among ever-married women in WHO'S WHO in 1948, by educational attainment and occupation.

EDUCATION AND OCCUPATION	MARRIED EVER NUMBER	PERCENTAGE DISTRIBUTION BY AGE AT FIRST MARRIAGE								MEDIAN AGE AT FIRST MARRIAGE
		Total	Under 20	20–24	25–29	30–34	35–39	40–44	45 +	
ALL CLASSES	1,232[1]	100.0	7.8	43.5	24.2	12.3	5.8	3.2	3.2	25.4
By Education										
Doctor's Degree	143	100.1	4.9	17.5	32.9	14.7	10.5	9.8	9.8	29.7
Master's Degree	92	100.1	2.2	33.7	25.0	19.6	13.0	2.2	4.4	28.3
Bachelor's Degree	329	99.9	2.4	41.9	29.8	14.0	6.4	3.0	2.4	26.4
College 1–3	243	100.0	11.5	46.1	24.3	9.1	4.1	2.9	2.0	24.7
High School 1–4	104	99.9	10.6	57.7	14.4	9.6	1.9	1.9	3.8	23.9
Below High School	3	*								
"Special"	95	100.1	10.5	46.3	26.3	11.6	3.2	1.1	1.1	24.2
"Private"	179	99.9	14.5	53.6	12.8	11.1	4.5	1.7	1.7	23.8
Unknown Education	44	100.0	9.1	65.9	15.9	6.8	2.3	—	—	23.6
By Occupation										
Teachers (Except College)	25	100.0	—	24.0	24.0	4.0	32.0	16.0	—	33.0
College Officials and Teachers	101	100.1	3.0	25.7	24.8	14.9	12.9	8.9	9.9	29.8
Musicians and Singers	42	100.1	9.5	28.6	42.9	11.9	4.8	2.4	—	26.9
Public Officials	57	100.1	10.5	36.8	24.6	19.3	5.3	—	3.6	26.0
Welfare Workers	64	100.1	3.1	43.8	29.7	7.8	6.3	4.7	4.7	26.0
Editors, Reporters, etc.	80	100.1	8.8	40.0	30.0	13.8	2.5	—	5.0	25.7
Business Women	39	100.1	15.4	35.9	23.1	5.1	7.7	7.7	5.2	25.3
Authors	366	99.9	6.0	48.9	23.5	12.3	6.0	1.9	1.3	25.0
Artists	73	100.0	8.2	49.3	21.9	11.0	4.1	1.4	4.1	24.7
Political Party Committee Women	78	100.1	16.9	46.5	25.4	8.5	—	2.8	—	24.6
Club Women	122	100.0	4.4	62.8	18.6	8.8	1.8	0.9	2.7	24.4
Actresses and Dancers	72	100.1	18.1	41.7	19.4	13.9	4.2	1.4	1.4	24.3
Other Occupations	129	100.0	7.8	37.2	21.7	17.8	5.4	5.4	4.7	26.7

[1] Excludes cases classified as "unknown age at first marriage."
* Percentages not computed.

those reporting "special" education, 23.9 for those limited to 1–4 years of high school, and 23.8 for those reporting "private" tutoring only.

By occupation the median age at first marriage extends from 24.3 for the actresses and dancers to 29.8 for the college officials and teachers, and to 33.0 for the other teachers. About 67 per cent of the ever-married club women as compared with 29 per cent of the college officials and teachers were under 25 when they first married.

Number of Times Married. Not only the current marital status but also the number of times ever married was coded on the basis of marriage histories. It is difficult to assess the accuracy of the data regarding multiple marriages. On the positive side is the effort of the editors to make WHO's WHO a valuable source for genealogical reference. Also, full records of previous marriages were given for the few women in WHO's WHO known by the writers to have been married previously. On the other hand, this was not always the case with reference to the few men in WHO's WHO known by the authors to have been married more than once. Doubtless some of the women also failed to report previous marriages and the results concerning proportions married two or more times probably err on the low side.

In spite of the limitations of the data, the results are rather interesting, particularly from the standpoint of internal differences. The data for all women relate to 2,406 or all except three who were coded as unknown with reference to times married. Of these, 40 per cent reported no marriage, 51 per cent reported one, and about 9 per cent reported two or more. In terms of numbers, 179 reported two marriages, 23 reported three, and 4 reported four marriages. When the population base is restricted to the ever-married women, as in Table 9, we find that approximately 86 per cent of the ever-married reported only one marriage, 12.5 per cent reported two marriages, and 2 per cent reported three or four.

At least in a general way multiple marriage is inversely re-

lated to educational attainment. Thus the proportion of ever-married women reporting two or more marriages is 8 per cent for holders of the doctor's degree, 6 per cent for those with the master's, 12 per cent for those with the bachelor's, 14 per cent for the college 1–3 group, 21 per cent for the high school 1–4 group, 15 per cent for the "special" education group, and 22

Table 9. Number of times married among ever-married women in WHO's WHO in 1948 by educational attainment and by occupation.

EDUCATION AND OCCUPATION	NUMBER WOMEN	PERCENTAGE DISTRIBUTION BY NUMBER OF TIMES MARRIED				
		Total	Married Once	Married Twice	Married 3 Times	Married 4 Times
ALL CLASSES	1,436[1]	100.1	85.7	12.5	1.6	0.3
By Education						
Doctor's Degree	156	100.0	91.7	7.7	0.6	—
Master's Degree	100	100.0	94.0	6.0	—	—
Bachelor's Degree	355	100.0	88.2	11.0	0.8	—
College 1–3	292	100.0	86.3	12.3	1.4	—
High School 1–4	126	100.1	79.4	18.3	2.4	—
Below High School	3	•				
"Special"	137	100.0	84.7	13.1	1.5	0.7
"Private"	208	99.9	77.9	16.8	3.8	1.4
Unknown Education	59	100.1	81.4	15.3	3.4	—
By Occupation						
College Officials and Teachers	109	100.0	93.6	5.5	0.9	—
Public Officials	69	100.0	92.8	5.8	1.4	—
Other Teachers	26	100.0	92.3	7.7	—	—
Club Women	122	100.0	91.8	6.6	1.6	—
Editors, Reporters, etc.	99	100.0	89.9	8.1	2.0	—
Welfare Workers	68	100.0	89.7	10.3	—	—
Political Party Committee Women	78	100.0	88.5	11.5	—	—
Artists	91	100.0	86.8	13.2	—	—
Authors	425	99.9	84.2	14.8	0.7	0.2
Musicians and Singers	66	100.0	80.3	15.2	3.0	1.5
Business Women	43	99.9	76.7	20.9	2.3	—
Actresses and Dancers	95	100.0	58.9	27.4	11.6	2.1
Other Occupations	145	100.0	89.7	10.3	—	—

[1] Excludes three women for whom "times married" was not coded.
• Percentages not computed.

per cent for the ever-married women reporting only private instruction.

By occupation, multiple marriages extended from none at all for the few ever-married librarians and church workers, to 41 per cent for actresses and dancers. The proportion of remarriages among ever-married women is 6 per cent for the college presidents, deans, and professors, 8 per cent for the other teachers, 7 per cent for public officials, 8 per cent for club women, 10 per cent for editors, reporters, etc., 10 per cent for professional welfare workers, 12 per cent for political party committee women, 13 per cent for artists, 16 per cent for authors, 20 per cent for musicians and singers, and 23 per cent for business women.

The median age at second marriage was 38.0; about one-fifth of the second marriages occurred before age 30 and 11 per cent after age 50.

A special tabulation was made to ascertain the extent to which remarriages of women in WHO'S WHO were preceded by divorce as compared with widowhood. The sketches provided information on this point for only 140 of the 237 remarriages listed. Of these, 59 per cent were preceded by divorce and 41 per cent preceded by decease of the former husband. It seems likely that the relative importance of divorce would be even higher if the 97 "unknowns" could be properly subdivided.

Fertility. The fertility data available from the sketches in WHO'S WHO are subject to important limitations. In preparation for the 1926–1927 edition the editors initiated the practice of requesting the subjects to list the names of their offspring. The expressed reason for this was that of making WHO'S WHO a more valuable source for genealogical reference in the future. On the basis of their tabulations from the 1926–1927 edition, Huntington and Whitney estimated that perhaps 50 per cent of the men not reporting any children in that edition actually had children. They also expressed the view, however, that this percentage was smaller for women and that the general

completeness of reporting of children would tend to improve in future editions.[30]

Although other factors are present, a suggestion that there has been improvement in the completeness of reporting of offspring since the 1926–1927 edition is afforded by a few comparisons of Cope's findings from that edition with those of the present study. Among 531 ever-married women studied by Cope, 287 or 54 per cent did not report any children. The average number of children reported was 2.4 per mother, 1.1 per ever-married woman, and 0.59 per woman (single or married).[31] Among the 1,437 ever-married women in the last edition of WHO's WHO, 621 or 43.2 per cent did not report any children. The average number of children reported was 2.2 per mother, 1.2 per ever-married woman and 0.75 per woman (single or married).

Although difficult to assess precisely, the fact that 127 or about 7 per cent of all children reported by women in WHO's WHO were designated as "deceased" would seem to augur well for a reasonably complete reporting of offspring in WHO's WHO. Eighty-three of the women listed one deceased child each, and twenty-two listed two each. Deceased children, of course, were included for purposes of fertility analyses, but adopted and stepchildren were not.[32]

Whatever may be the extent of underreporting of children by women in the last edition of WHO's WHO, there is little doubt that this group is considerably less fertile than women of similar age in the general population. This is pointed up in Figure 10, based on Table 10. The top bar shows a distribution of 1,086 ever-married women 40–74 years of age in WHO's WHO by number of children ever born. For comparison, the second bar shows a similar distribution for ever-married white

[30] Huntington and Whitney, *op. cit.*, p. 160.

[31] Derived from Cope, *op. cit.*, p. 217.

[32] Eighteen ever-married women listed names of a total of 15 adopted children and 17 stepchildren. Of nine ever-married women listing names of adopted children, five listed 1 each, three listed 2 each, and one listed 4. Of the nine women reporting stepchildren, four listed 1 each, two listed 2 each, and three listed 4 each. In addition, nine single women reported a total of 13 adopted children, five with 1 each, and four with 2 each.

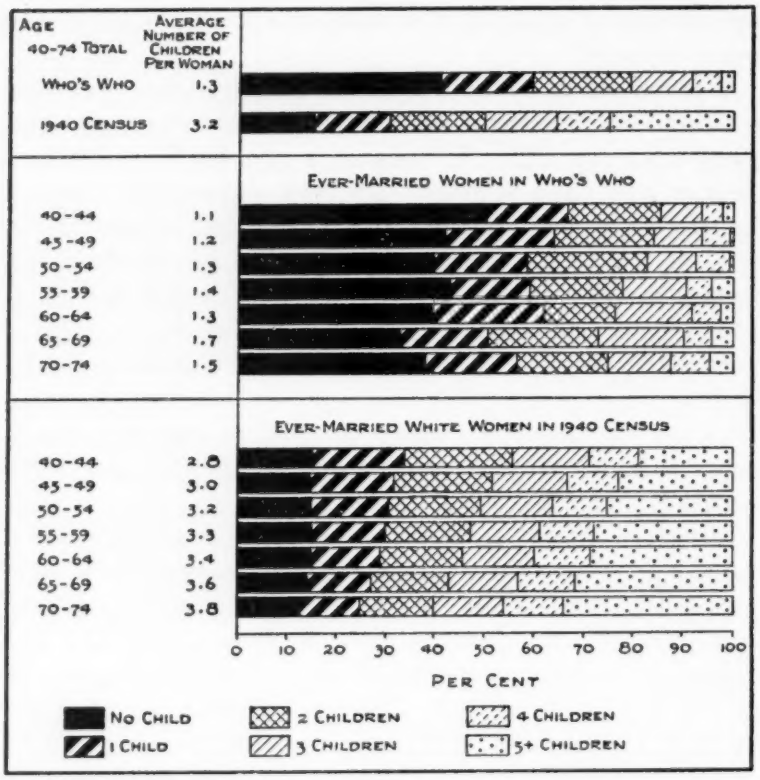

Fig. 10. Distribution of ever-married Who's Who women 40–74 years of age by number of children ever born, and comparable data for white women in the 1940 Census. *See* Table 10.

women 40–74 years of age in the United States in 1940. Among Who's Who women of this age approximately 41 per cent did not report any children. The proportion reporting one child is 19 per cent, two children 20 per cent, three children 12 per cent, four children 6 per cent, and five or more children 3 per cent. In contrast, among ever-married white women reporting on number of children ever born in the 1940 Census, only 15 per cent were childless and 25 per cent bore five or more children. The average number of children reported per ever-married woman 40–74 is 1.3 for the Who's Who group and 3.2 for the 1940 Census group. The relative difference is smaller,

however, with respect to average number of children per *mother* of this age: 2.3 and 3.7, respectively, for the WHO's WHO and Census groups.

In the lower sections of Figure 10 the data are shown for specific ages within the 40–74 span. The general decline in the birth rate is reflected by the tendency of the older women to be more fertile than the younger ones. It will be noted, however, that in each age category the percentage of WHO's WHO women classified as childless, is more than double that for women in the 1940 Census.

The relatively low fertility of the WHO's WHO women, as

Table 10. Children ever born reported by ever-married WHO's WHO women 40–74 years of age in 1948 and by ever-married white women of similar age in the United States in 1940.

AGE	BIRTHS PER 100 WOMEN	NUMBER WOMEN	PERCENTAGE DISTRIBUTION BY NUMBER OF LIVE BIRTHS						
			Total	No Child	One Child	Two Children	Three Children	Four Children	Five or More Children
	EVER-MARRIED WOMEN IN WHO'S WHO IN 1948								
40–74 TOTAL	134	1,086	100.0	40.7	18.8	19.8	12.2	5.8	2.7
40–44	113	134	100.0	50.0	16.4	18.7	8.2	4.5	2.2
45–49	118	172	100.0	41.9	21.5	20.3	9.9	5.8	0.6
50–54	130	198	100.0	39.4	18.7	24.2	10.1	6.6	1.0
55–59	137	191	99.9	42.9	15.7	18.8	13.1	5.2	4.2
60–64	135	159	100.0	39.0	22.6	14.5	15.7	5.7	2.5
65–69	165	129	100.1	32.6	17.8	22.5	17.1	5.4	4.7
70–74	154	103	99.9	37.9	18.4	18.4	12.6	7.8	4.8
	EVER-MARRIED WHITE WOMEN IN THE 1940 CENSUS[1]								
40–74 TOTAL	319	14,770,940	100.1	14.8	15.8	18.7	14.8	10.8	25.2
40–44	276	3,126,880	100.0	15.2	18.7	21.9	15.3	10.1	18.8
45–49	302	2,945,980	99.9	14.8	16.7	20.0	15.3	10.6	22.5
50–54	316	2,571,520	99.9	14.9	15.7	18.6	14.8	10.9	25.0
55–59	333	2,110,860	100.0	15.2	14.7	17.2	14.3	10.9	27.7
60–64	341	1,715,160	100.1	15.0	14.0	16.9	14.3	11.2	28.7
65–69	363	1,366,780	100.1	14.0	13.1	15.8	14.1	11.4	31.7
70–74	382	933,760	100.2	12.5	12.4	14.8	14.3	12.1	34.1

[1] The Census data, based upon results of a "Sample C" tabulation relating to women reporting on number of children ever born, from Sixteenth Census of the United States, 1940: POPULATION—DIFFERENTIAL FERTILITY 1940 AND 1910. FERTILITY FOR STATES AND LARGE CITIES. Washington, Government Printing Office, 1943, pp. 7 and 13.

compared with all white women of comparable age, appears to be due in large measure to the fact that the former group are more educated and more urban. The fertility rate for all native-white, urban ever-married women 40–74 years of age and reporting 4 or more years of college in the 1940 Census was only 34 per cent higher than that for WHO's WHO women of comparable education and age (rates standardized for age). At the college 1–3 level the fertility of urban native-white Census wives was 42 per cent higher, and at the high school 1–4 level 77 per cent higher than that of WHO's WHO women of comparable age and educational attainment. The standardized average number of children per ever-married woman 40–74 years of age in WHO's WHO by educational attainment was 1.3 for those with college degrees, 1.4 for those attending college 1–3 years, and 1.2 for those reporting high school but no college attendance. The corresponding averages for the ever-married urban native-white women of comparable age in the 1940 Census were 1.8, 1.9, and 2.1.[33]

Fertility rates have been computed for WHO's WHO women in more detailed educational classes and in other types of subdivisions. These relate to once-married women 40 years of age and over, experiencing no broken marriage before age 45, and hence tend to be somewhat higher than those relating to *ever-married* women 40–74 years of age.

By education, the lowest fertility rates are exhibited by women with doctor's degrees and by those reporting "special" education. (*See* Figure 11.) In the former group there was an average of only nine-tenths of one birth per woman, and in the latter group an average of 1.0 birth per woman. The averages were 1.2 for women with the master's degree, 1.6 for those with the bachelor's degree, and for those reporting 1–3 years of college, 1.5 for those reporting private schooling, and 1.8 for those reporting some high school but no college training.

The proportion classified as childless is nearly two-thirds (63

[33] Computed from Sixteenth Census of the United States, 1940: POPULATION—DIFFERENTIAL FERTILITY 1940 AND 1910. WOMEN BY NUMBER OF CHILDREN EVER BORN. Washington, Government Printing Office, 1945, pp. 156–157.

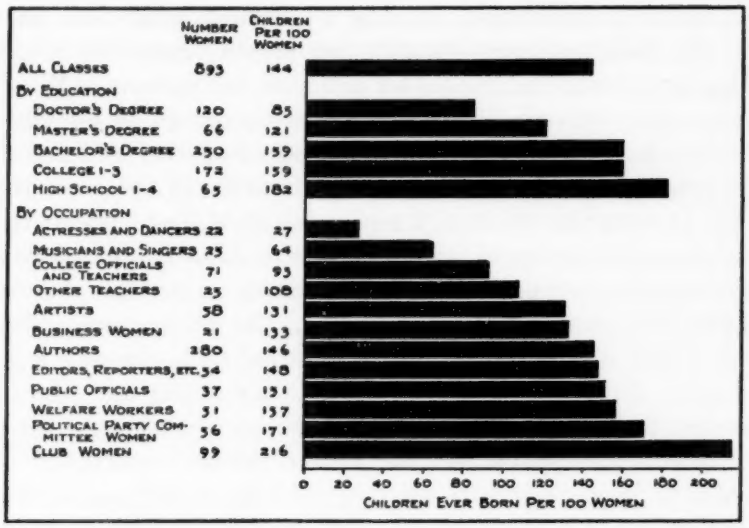

Fig. 11. Fertility by educational attainment and occupation among married women in Who's Who, 40 years of age and over. (Data restricted to women married only once and reporting no broken marriage before age 45.)

per cent) for the married women with doctor's degree, 41 per cent for those with the master's degree, and 35 per cent for those with the bachelor's degree. It is interesting to note, however, that the largest family represented (12 children) is that of a woman with a doctor's degree and the next largest (10 children) was that of a woman with a bachelor's degree.

Except for a somewhat lower rate (1.2 births per once-married woman) for women living in cities of 1,000,000 population or more, there appears to be little relation between fertility and size of community in which the women in Who's Who reside.

Slightly less than one-half of the married women reported religion, so fertility rates by religion are not highly trustworthy. The average number of births per woman among those stating religion is 2.5 for the Jews, 2.1 for the Catholics, and 1.6 for the Protestants. It should be emphasized, however, that the rates for the Jewish and Catholic women are based on only 20 and 35 cases, respectively (Protestant, 356 cases), so they are subject to high degrees of statistical error.

Studies of differential fertility by occupational class have usually indicated conspicuously low fertility rates for actors. This tradition is maintained for actresses and dancers in WHO's WHO, although only 22 are represented in the group restricted to once-married women 40 years of age and over and having no broken marriage before age 45. However, of these twenty-two, 18 report no children, 2 report one child, and 2 report two children, an average of 0.3 per actress or dancer. The twenty-five musicians reported a total of 16 births, an average of about 2 per three women, or 0.6 per woman. The seventy-one college presidents, deans, and professors reported 66 births or 0.9 per woman. Additional averages were 1.3 for artists and also for women in business pursuits, 1.5 for authors, newspaper correspondents, and public officials, 1.6 for welfare workers, 1.7 for political party committee women, and 2.2, the highest, for club women.

Finally, when the facts of low proportions married, late age at marriage, and low fertility are brought together, we have a situation something like this. Nearly two-thirds of all women (single and married) 40 years of age and over in WHO's WHO were childless. Only about three children were reported for every four women in WHO's WHO.

In conclusion, it is clear that the woman in WHO's WHO can hardly be called typical of the American woman. She is better educated and more likely to be unmarried. If married, she is likely to marry at a later age, and then to have fewer children. Her chief interest probably tends to lie not in her family, but in her work or career. In this career and in the preparation for this career—her education—perhaps lies the key to the difference between the WHO's WHO woman and the "average" American woman. The time and attention given by the latter toward seeking a husband, raising a family, and running a household, appear to be spent in large part by the WHO's WHO woman in working toward and being successful in a career. That perhaps is the chief explanation for the large proportion of unmarried, for the late age at marriage, and for the high

proportion of childlessness. It is recognized, of course, that in some cases the causal relation may run in the other direction and that some women drift into careers because marriage opportunities are lacking or because of failure to have children.

It is well to keep in mind, also, that there are many "family women" in WHO'S WHO, perhaps notably among those who turned to club work and various committee activities after their children had been reared. Even among the others there are doubtless many who "accomplished something out of the ordinary" without sacrificing a primary interest in marriage, children, and a normal family life.

SUMMARY

This study is based upon data available in the printed sketches of 2,409 women in the 1948–1949 edition of WHO'S WHO IN AMERICA. Women whose permanent addresses appeared to be in foreign countries and those as being deceased before the volume was published were excluded from the study.

The women gained recognition in a wide variety of activities but those engaged in formal education and the authors constituted 45 per cent. The addition of artists, editors and columnists, public officials, club women, actresses and dancers, musicians and singers, professional welfare workers, and political party committee women brings the total to about 86 per cent.

Each state is represented as a place of residence of WHO'S WHO women but marked concentrations in the Northeast; Washington, D. C.; Illinois; and California were found. The concentration by place of birth was less pronounced.

The WHO'S WHO women were also concentrated more heavily in large cities than is the general population. Furthermore, although the data do not permit precise measurement, they suggest that rural areas (including villages under 2,500 population) were the birthplaces of only about one-half the "expected" proportion of WHO'S WHO women. Approximately one-third of the women reported such areas as birthplaces but

nearly two-thirds of the population of 1890 (the Census year nearest the 1891 median year of birth of WHO's WHO women) resided in such areas.

The median age of WHO's WHO women was approximately 57. Only 3 per cent were under 35 and nearly 29 per cent were 65 years of age and over.

Nearly three-fourths (72 per cent) of WHO's WHO women reported some college attendance. Over half (55 per cent) reported college degrees. By occupation, the proportion reporting college degrees extended from 96 per cent for college officials and teachers to 4 per cent for actresses and dancers.

Forty per cent of the WHO's WHO women reported no marriage. By education, this proportion was highest for women reporting master's and doctor's degrees (66 and 63 per cent, respectively), and lowest (17 per cent) for those reporting "private" education. By occupation, the proportion was highest (86 per cent) for librarians and lowest (5 per cent) for the political party committee women.

The median age at first marriage was 25.4 for ever-married women reporting relevant data in WHO's WHO, as compared with 21.7 for women 15–74 years old (married once and husband present) reporting in the 1940 Census. However, the differences are somewhat smaller in age-specific comparisons within the 40–74 age range.

By education, the median age at first marriage was highest (29.7) for holders of the doctor's degree and lowest (23.8) for those reporting "private" education. By occupation, it was highest (33.0) for officials and teachers in schools except colleges, next highest (29.8) for college officials and teachers, and lowest (24.3) for actresses and dancers.

Approximately 14 per cent of the ever-married women in WHO's WHO reported more than one marriage. By education, this proportion extended from 6 per cent for holders of the master's degree to 22 per cent for those reporting "private" education. By occupation, it extended from none at all for the small groups of ever-married librarians, professional wel-

fare workers and religious workers, to 41 per cent for the actresses and dancers.

Despite the described limitations of the fertility data, there is little doubt that the WHO'S WHO women are characterized by relatively high proportions childless and by generally low fertility levels. Approximately 41 per cent of the ever-married women 40–74 years of age did not report any children. The children reported (including the deceased but not adopted or stepchildren) yielded averages of 2.3 per mother and 1.3 per ever-married woman 40–74 years of age. Among ever-married white women 40–74 reporting in the 1940 Census, only 15 per cent reported no children, and the corresponding averages were 3.7 children ever born per mother, and 3.2 per ever-married woman.

Even among WHO'S WHO women, fertility appears to be inversely associated with amount of formal education. By occupation, fertility rates were lowest for the actresses and dancers and highest for the club women.

ANNOTATIONS

LENGTH OF LIFE: A STUDY OF THE LIFE TABLE[1]

THIS revised edition of LENGTH OF LIFE is an entirely new book, and not in any sense a mere revision of the first edition. Every chapter has been completely rewritten, and two new chapters have been added. Never has such a wealth of information concerning human mortality and longevity been assembled in a single publication; and this volume will be, for many years to come, an invaluable reference book for sociologists, demographers, public health workers, and statisticians. The first impression which its perusal has made on this reviewer is a sense of the prodigious amount of labor that must have gone into its preparation and the great saving in time and effort that this will represent for future users, who will find brought together in one place material from literally hundreds of sources. The rewriting of the various chapters has not been confined to bringing them up to date and adding new material. At the same time, the manner of presentation has been much improved, so as to render the book more readable, interesting, and usable. In particular, the addition of summaries at the end of a number of the chapters adds much to its usefulness.

An introductory chapter summarizes the available information concerning the maximum span of human life and explains the general plan and structure of the life table. This is followed by two historical chapters, of which the first traces the progress of human longevity up to the end of the 19th century, while the second describes the gain in longevity in the United States in recent years. Chapter 4 deals with geographic variations in longevity and mortality within the United States. Under the

[1] Dublin, Louis I.; Lotka, Alfred J.; and Spiegelman, Mortimer: LENGTH OF LIFE: A STUDY OF THE LIFE TABLE (Revised Edition). New York, the Ronald Press Company, 1949, xxv + 400 pp.

title "Biological Aspects of the Life Table" Chapter 5 is concerned with the analysis of the life table by causes of death. This includes a discussion of the distribution of deaths by cause and age, the range of incidence and concentration of ages at death for selected principal causes, the probability of eventually dying from a specified cause, and the number of years of life forfeited to individual causes. Chapter 6 describes all the important investigations bearing on the question of whether the tendency to be long-lived is inherited, and the relative importance of heredity and environment in connection with longevity.

This is followed by a new and especially valuable chapter dealing with "Biological Factors Influencing Longevity and Mortality." The factors considered include stillbirth, premature birth, age of parents and order of birth, interval between births, plural births, the Rh factor, risks associated with pregnancy and childbirth, sex differences in general mortality, and marital status. The unusually complete and thoughtful discussion of sex differences in mortality seems to the reviewer especially valuable. Chapter 8 outlines the development of medical and sanitary science, with particular reference to its effects on mortality and longevity. The next chapter is a new one entitled "Forecasts of Mortality and Longevity," which contains a commendably full discussion of hypothetical life tables, mortality forecasts for population projection, and generation life tables. Chapter 10, on "Mortality in Relation to Physical Condition," has been considerably enlarged to include data from clinical and other studies as well as those derived from the experience of life insurance companies. Chapter 11, on "Longevity in Relation to Occupation," has been brought up to date.

Chapter 12, "The Application of the Life Table to Population Problems," explains clearly and in considerable detail the traditional measures of reproductivity and natural increase of population and certain associated concepts. These include the true rate of natural increase, the net reproduction rate, the gross reproduction rate, the replacement index, and the stable age distribution. The time trend of rates of population growth and their geographic distribution—both within the United States and in the world as a whole—are described. Other sections of

this chapter deal with the characteristics of a population growing according to the logistic law, the aging of the population and the social consequences of increased longevity, the effects of changing age distribution on the national economy, and applications of the life table based on the survival of two or more persons, such as duration of marriage and orphanhood. The section on measures of reproductivity and natural increase has been rendered more useful by the addition of a detailed numerical illustration and a further discussion of the interrelation of the various measures. However, it would be more useful, in the opinion of the reviewer, if more prominence had been given in the text to the recent critiques of the traditional measures (now relegated to a footnote) and, in particular, if some reference had been made to the valuable work of Hajnal[2] in this connection.

Chapter 13 discusses the application of the life table to life insurance, the determination of the economic value of a wage earner, depreciation of physical property and other economic problems. Chapter 14 describes the more important life tables based on the experience of life insurance companies, and Chapter 15 deals with the construction of life tables. After some discussion of the data necessary for this purpose, and the limitations of such data, an abbreviated method for constructing an abridged life table is described, as well as a method of interpolation for supplying the values not given by the abridged process. An appendix gives a large number of expectation of life values and mortality rates at decennial ages for the United States and its subdivisions and for many foreign countries, according to life tables for both recent and past periods. A complete list of sources of these data is included, and, in addition, the American Experience table and the Commissioners 1941 Standard Ordinary Mortality table are given in full.

In a book covering such a wide field and dealing with so many topics which are matters of opinion and even of controversy it is inevitable that there will be statements with which some readers will not entirely agree. Without wishing to appear critical, the reviewer thinks it will be helpful to some users of

[2] Hajnal, J.: Aspects of Recent Trends in Marriage in England and Wales. *Population Studies*, June, 1947, pp. 72–98, Analysis of Birth Statistics in the Light of the Recent International Recovery of the Birth Rate. *Ibid.*, September, 1947, 1, pp. 137–164.

the book to mention certain of his own reservations concerning certain statements. In connection with the discussion of mortality by nativity on pages 57–8, it is not unlikely that there may be some tendency to conceal foreign birth in the census returns, which is not fully reflected in the reporting of deaths. This would result in overstatement of the mortality of the foreign-born. In the discussion of urban and rural life tables on pages 72–74 it is not clearly brought out that comparisons based on deaths by place of occurrence may be of little value because of the considerable number of deaths of rural residents which occur in urban hospitals. On page 97 it is stated that the figures given "do not give the complete picture of diabetes mellitus as a factor in curtailing life, since the death reports fail to indicate many of the diabetics who die from other causes, mainly cardiovascular-renal diseases." On the other hand, it might be pointed out that the system of assigning causes of death heretofore employed in the United States gives diabetes a high priority as compared with many other conditions which may be mentioned in the death certificate, and this may be thought to have resulted in attributing to this cause a number of deaths in which other conditions may have played a more important role. This is less true of the new system of assigning causes of deaths which is now coming into use, starting with the deaths of 1949. Table 48 on page 195 would be of more interest if the time period covered by the data were indicated. In Chapter 15, in explaining the method of interpolation to get values of the life table functions for single years of age, no indication is given of how to break up the age group 2–4. In order to interpret properly the discussion of "life insurances reserves for other types of policies" on page 274, it is necessary to bear in mind that the term "reserve fund" is always used by the authors in referring to the total reserve on a group of similar policies, while they refer to the reserve on an individual policy as the "reserve per survivor."

These criticisms and comments are all on minor points. This book is a monumental achievement, and its authors have earned the gratitude of all those who have need of data on the duration of human life.

THOMAS N. E. GREVILLE

TWIN FAMILY STUDY OF CHRONIC DISEASE[1]

For many years the family has been considered a basic unit for epidemiological investigation of the acute infectious diseases. Chapin introduced the method—a quantitative description of familial aggregation of disease—as early as 1888. In recent years the concept of epidemiology has broadened and now includes the study of some of the chronic diseases, such as tuberculosis and rheumatic fever. Frost experimented with and described the use of the family as the unit of study of differences in the risk of attack of tuberculosis for persons in familial contact with the disease compared with the general community risk.

The "family method" of epidemiological investigation used by Chapin and Frost and his students had the specific purpose of describing the spread of infectious disease in the immediate environment of an index or primary case. The "family method" has recently been combined with the "twin method" and used as an effective means of exploring the possibility of genetically determined resistance factors which may affect the incidence of chronic infectious disease and other chronic conditions.

The "Twin Family Method," as pointed out by Kallmann and Reisner, is the best available method for clarification of the part played by genetic factors in the variability of the pathologic effect produced by a specific microorganism, the tubercle bacillus. This method provides six categories of sibship pairs; namely, monozygotic twins, dizygotic twins of the same sex, dizygotic twins of opposite sex, full siblings, half siblings, and step siblings.

The material used for analysis by Kallmann and Reisner consisted of 308 complete twin families with 616 twin partners, 930

[1] a. Kallmann, J. Franz and Reisner, David: Twin Studies of the Significance of Genetic Factors in Tuberculosis. *The American Review of Tuberculosis,* June, 1943, XLVII, No. 6, pp. 549–574.

b. ———————————: Twin Studies on Genetic Variations in Resistance to Tuberculosis. *Journal of Heredity,* September, 1943, 34, No. 9, pp. 269–276 and 293–301.

c. Kallmann, J. Franz: The Genetic Theory of Schizophrenia: An Analysis of 691 Schizophrenic Twin Index Families. *American Journal of Psychiatry,* November, 1946, 103, pp. 309–322.

d. Kallmann, J. Franz and Sander, Gerhard: Twin Studies on Aging and Longevity. *Journal of Heredity,* December, 1948, 39, No. 12, pp. 349–357.

full siblings, 74 half siblings, 688 parents, and 226 marriage partners of twin patients. The proportion of monozygotic to dizygotic twin pairs was about 1:3, a ratio consistent with that found for twins in the general population.

The method used for classification of twin partners in respect to their zygotic origin was the "modern similarity method," that is, similarity in certain anatomical traits. The clinical data required for a diagnosis of tuberculosis included complete histories, chest x-ray films, and sputum examinations.

The care with which the study was done is revealed by the authors. "The diagnostic aspects of the study were strictly a matter of the investigators' research, since it was advisable to ascertain them beyond reasonable doubt and in accordance with a uniform system of classification. Whenever possible, therefore, the diagnosis of both tuberculosis and zygocity was made on the basis of personal examination and extended observation."

Some of the significant findings of this investigation are as follows:

> The chance of developing tuberculosis increases in strict proportion to the degree of blood relationship to a tuberculous index case. The difference in morbidity between dizygotic and monozygotic twin partners amounts to a ratio of 1:3.5.
>
> The difference between dizygotic and monozygotic co-twins increases to a ratio of 1:16, if the similarities in extent, course and eventual outcome of the disease are taken as additional criteria of comparison.
>
> The consistent differences in tuberculosis morbidity among the various sibship groups of the twin index cases *cannot* be adequately explained on the basis of a simple correlation between closeness of blood relationship and increasing similarity in environment with correspondingly intensified opportunity for infection.
>
> The analysis of the morbidity distribution in the sibship groups indicates that resistance to tuberculosis is modified by a heredoconstitutional mechanism which seems to be multifactorial in its genetic nature.

The "Twin Family Method" was used also by Kallmann in a

special study of schizophrenia (3). Twin index cases were collected from the resident populations and new admissions of all mental hospitals under the supervision of the New York State Department of Mental Hygiene. The requirements were that the index cases be born by multiple birth and that they were admitted with a diagnosis of mental disease. All were reported by twenty institutions within a period of nine years. The twin diagnosis was based on findings obtained by the "similarity method."

The frequency of schizophrenia in the different population groups which comprised the families of the twin index cases is of considerable interest. The data are as follows:

Relation to Index Case	*Per Cent Diagnosed as Schizophrenia*
Parents	9.2
Husbands and Wives	2.1
Step Siblings	1.8
Half Siblings	7.0
Full Siblings	14.3
Dizygotic Co-twins	14.7
Monozygotic Co-twins	85.8

The similarity of full siblings and dizygotic co-twins is of special interest. According to Kallmann, "If the assumed genetic factor exists and the part played by the twinning factor is negligible, the statistical expectation will be that the morbidity rates for full siblings and dizygotic twin partners should be about the same, but they should clearly differ from the rates for the other sibship groups."

For monozygotic co-twins, Kallmann indicated that a rate of 100 per cent would be expected theoretically in regard to a strictly hereditary trait. Since the rate among monozygotic co-twins in this study (85.8 per cent) was somewhat below the expected, he concluded that "from a biological standpoint, the finding classified schizophrenia as both preventable and potentially curable." It is difficult to accept Kallmann's line of reasoning at this point because it seems to be based upon complete confidence that there can be no possibility of error in the

diagnosis of either monozygocity or schizophrenia; that is, there were no missed cases in either category.

One of the chief conclusions from the study was "The predisposition to schizophrenia; that is, the ability to respond to certain stimuli with a schizophrenic type of reaction, depends on the presence of a specific genetic factor which is probably recessive and autosomal."

Kallmann is using the "Twin Family Method" also in an investigation of aging and longevity (d). During a period of three years a total of 1,602 twin index cases, both of whom survived to 60 years of age, were studied. "In a comparison of the life spans of the same sexed twin partners, the significance of genetic factors in longevity was demonstrated by the finding that the average intra-pair difference of monozygotic pairs (36.9 months) is only about one-half that of dizygotic pairs (78.3 months). This inter-group difference is expected to increase with the progress of the study."

These "Twin Family Studies" are of interest and value both to the geneticist and to the epidemiologist. As the concept of epidemiology broadens and the field of work is extended so as to include more of the chronic diseases, this method of study may prove most useful.

JEAN DOWNES

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REAPPRAISING OUR IMMIGRATION POLICY[1]

IN VIEW of the public concern over the problems of displaced persons and in view of the current discussions of the wisdom and adequacy of the Displaced Persons Act of 1948, the March, 1949, issue of *The Annals* was devoted to the general topic "Reappraising Our Immigration Policy." Dr. Hugh Carter served as editor of this volume and most of the contributors of the twenty-one articles are easily recognized as authorities in their respective fields.

[1] Carter, Hugh (ed.): Reappraising Our Immigration Policy. *The Annals of the American Academy of Political and Social Science,* Philadelphia, March, 1949, Volume 262.

The papers are classified under four sections entitled: "Historic Aspects of Immigration," "Demographic Factors in Immigration Policy," "Assimilation of the Foreign Born," and "Current Immigration Problems in the United States." Nothing approaching a resume of the individual articles will be attempted but a few of the high lights will be mentioned.

Briefly stated, the chief points appear to be as follows: The United States has not been absorbing large numbers of immigrants in the past thirty years; in certain fields of our economy a need for labor exists; owing to demographic trends in Europe, that continent cannot resume her former role as a perennial source of labor supply to the United States, even if the barriers were lifted; the period of rapid population growth in the United States has passed; and European displaced persons loom large in current immigration problems of the United States.

Since this country has had no large numbers of immigrants in the past three decades, the question arises as to whether it still can absorb large numbers. This question is considered by several of the writers. Dr. Wilbert E. Moore declares that "the United States has never been self-sufficient in manpower." Dr. A. Ross Eckler and Mr. Jack Zlotnick point to the successful absorption of large numbers in the past as "testimony to the needs of the country." Dr. Ewan Clague holds that "our long run employment prospects seem much brighter today than they did a decade ago" and suggests that at present a number of immigrants may be absorbed in the laboring and service occupations. Mr. Collis Stocking states his belief that through the use of such agencies as the United States Employment Service many gaps in our labor supply can be filled by immigrants. He calls for a positive program in this direction.

Dr. Kingsley Davis and Mr. Clarence Senior in their article, "Immigration from the Western Hemisphere," emphasize that this source of immigration has not filled the void created by the virtual cessation of European immigration. In discussing Mexican migration to this country, they note an increasing tendency for both countries to control this migration and express the belief that short-term contractual arrangements will answer many of the labor needs of the United States. These

authors also discuss the Puerto Rican migration to the continental United States. While Puerto Ricans are not legally classed as immigrants, they carry with them many of the problems characteristic of other Western Hemisphere immigrants. New data concerning this group in the United States and particularly in New York City are presented.

The migration potential of Europe is discussed by Dr. Dudley Kirk, Dr. Frank Lorimer, and Dr. Irene Taeuber. Their articles emphasize the fact that Europe is drying up as a source of immigrants for the United States. Dr. Kirk in his appraisal of European demographic trends concludes that even without the sharp curtailment of immigration to the United States by the Quota Acts and the economic depression, "demographic factors were at work reducing the underlying European migration potential." These factors Dr. Kirk lists as the declines in death and birth rates and in the rate of natural increase. The postwar increase in birth rates will not alter the basic trends. These births, he states, include a disproportionate number of first and second births, and thus no substantial increase in average family size can be forecast. He finds that decline in birth rates follows material progress and therefore a general decline in fertility levels has spread to Southern and Eastern Europe.

Dr. Lorimer in his article, "European Governmental Action Regarding Population," discusses the various means now being used by governments to direct population trends. Europe's main problem now, he states, is that of sustaining "its waning population." Dr. Taeuber takes much the same view in her article "Postwar Immigration from Germany and Italy" in which she presents an illuminating discussion of the economic and population problems of these two countries. Germany even now is faced with needs for manpower and Italy may be in the same position in twenty-five years.

No discussion of our future immigration policy is complete without an assessment of present population trends in the United States. Dr. Warren Thompson in his article, "The Demographic Revolution in the United States," sketches our demographic history and describes the changing situation in which the United States finds itself in regard to population

growth. Like Europe we are experiencing declining death and birth rates and therefore a fall in population growth. These demographic factors are producing such results as a decrease in the number of young workers, an aging population, and a differential birth rate appearing between urban and rural groups and between the high-income and low-income brackets. What the effects of these demographic factors at work will be are hypothetical. Dr. Thompson discusses their possible bearing upon the quality of population, our democratic institutions, and our economy.

Some pressure for a liberalization of our immigration policy has arisen as a result of the problem of the displaced persons in Europe. This situation poses the question of assimilation of the foreign born in the United States. An entire section of *The Annals* is devoted to this topic. A thorough examination of the adjustment of immigrants in past years constitutes a major portion of this section. In the article, "Adjustment of the Refugee to American Life," Dr. Maurice R. Davie and Dr. Samuel Koenig describe the general characteristics and economic and social adjustment of the earlier refugees from Fascism and Nazism and of the more recent displaced persons. The authors note the general willingness of these people to adopt American customs and their readiness to be assimilated.

Complementing this examination is Mr. Eugene M. Kulischer's article "Displaced Persons in the Modern World." Mr. Kulischer paints a much darker picture, however, for he is concerned with the people who are still displaced. He believes that the Displaced Persons Act of 1948 will bring help to a large part of Europe's homeless people but that even the limited problem of European displaced persons is far from being solved.

In the reviewer's opinion the most glaring omission in this collection of articles is the lack of a paper on Asia in the section devoted to demographic factors in immigration policy. Also, only incidental reference is made to the experiences of the new state of Israel. Otherwise, the ground is covered well and this with the small amount of repetition reflect careful planning by the editor. *The Annals* is to be commended for devoting an issue to this timely topic and most readers will join Dr. Hugh Carter in the "hope that the future policy, hammered out

through general discussion and debate, will be based on a mature consideration of all the factors involved."

JEANNE E. CLARE

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MEDICAL MISSIONS TO EUROPE[1]

FOR many years religious organizations have sent medical missions to areas with serious health problems, such as China, India, and Africa. Recently national and international government organizations have also taken an interest in health conditions in many parts of the world. In some cases, private and public groups have worked together on international problems. The World Health Organization recognizes the advantages of such collaboration and has made provision for cooperation with non-government groups of similar interest and purpose if they meet certain conditions.

Such collaboration was illustrated in a recent series of medical teaching missions to war-affected areas of Europe: Czechoslovakia (1946); Austria (1947); and Greece, Italy, Poland, and Finland (1948). The Unitarian Service Committee participated in organizing all of the missions. The United Nations Relief and Rehabilitation Administration co-sponsored the mission to Czechoslovakia, and the World Health Organization provided cooperation on the missions to Austria, Poland, and Finland.

The missions had two chief purposes:

1. Exchange of information on recent medical developments, considered especially important for personnel in areas which had

[1] Medical Teaching Mission to Czechoslovakia, July 3–September 1, 1946. American Unitarian Service Committee in cooperation with United Nations Relief and Rehabilitation Administration. Unitarian Service Committee, Division of Medical Projects, New York, N. Y., 1947, 1948, 49 pages.

Medical Mission to Austria, July 1–August 8, 1947. American Unitarian Service Committee in cooperation with World Health Organization Interim Commission. Unitarian Service Committee, Medical Projects, New York, N. Y., 1948, 46 pages.

Medical Mission to Greece and Italy, April 15–June 7, 1948. Unitarian Service Committee, Inc. Unitarian Service Committee, Inc., Medical Projects, New York, N. Y., 1949, 73 pages.

Medical Mission to Poland and Finland, July 1–August 27, 1948. Unitarian Service Committee, Inc. in cooperation with World Health Organization. Unitarian Service Committee, Inc., Medical Projects, New York, N. Y., 1949, 82 pages.

been out of touch with medical advances during the war period.

2. Promotion of international peace.

Outstanding medical professors from the United States, and in some cases other countries, were sent to particular areas of Europe to achieve these goals. They stayed for periods of five to eight weeks. Comments of these professors on conditions which they found have since been made available in a series of pamphlets published by the Unitarian Service Committee.

The following factors reflecting medical conditions were observed in most countries: (1) illness rates, (2) medical facilities, (3) medical service, and (4) medical education. The hardships of the war period had naturally affected each of these conditions in some areas.

Certain disease rates were high. The prevalence of tuberculosis was excessive in several countries. An estimated 20 per cent of the children under one year of age and 100 per cent of the adults in Poland had positive skin tests for tuberculosis. Other disease rates among children in Poland were also high, such as scarlet fever, pertussis, congenital syphilis, malaria, and typhus fever. In part of Czechoslovakia, dental disease was present in "severe epidemic proportion." Individuals in many areas were suffering from malnutrition.

Some medical facilities were outstandingly good: individual hospital buildings in Finland and Italy, one contagious disease unit in Finland, and the Vienna Institute of Pharmacology. However, many material needs existed. Hospital destruction had been severe in Poland. Laboratory equipment, x-ray supplies, and recent scientific journals were limited in several countries. Shortages of rubber gloves, suture material, and experimental animals were noted in Austria. In several places blood was hard to get and not used extensively. In Poland, where people were loathe to give it, some blood was being obtained at the lying-in hospitals, from the placenta after the umbilical cord had been divided.

High quality medical service was available in certain instances, such as some of the surgical work in Czechoslovakia and Austria. A good mental hygiene program, in which consideration was being given to the related effects of social and psychological factors on mental illness, was in operation in

Poland. Use of ingenuity to maintain high standards of service in the face of material shortages was sometimes evident, such as modification of a vacuum cleaner to provide a suction apparatus in an operating room.

The medical service also had important faults. In several areas neurosurgery had not been well developed. Pre and post-operative care characteristically lagged behind such care in the United States. Use of anaesthesia was limited in all countries. Even in Italy, which stood out as a country in which medical anaesthesiology was being developed, anaesthesia was not used for childbirth or for tonsillectomies in small children. To some extent this situation was attributed to the fact that in Italy "The patient is not regarded primarily as a human being, and hence, relief of pain is less important than it is in this country" (i.e., the United States).

Partly as a result of pressure to meet personnel shortages resulting from the war, many medical schools were overcrowded. For example, medical school enrollment in Austria was three times the pre-war level and in Rome, was six times the pre-war level. Declines in enrollment were expected, however. Many teachers were underpaid. In Greece, where student fees had dropped from the pre-war $100 to $35 a year, teachers were doing outside work to supplement their salaries.

In several medical schools the gap between teachers and students was great. The lecture system of teaching, in some cases with little laboratory work, was common. In Greece and Italy medical students suffered from limited contact with patients during school years and the lack of adequate subsequent hospital interne and residency programs. In most countries the pre-clinical sciences were under-emphasized in the medical curriculum. Several of the medical school libraries were very good, especially a departmental library in Italy containing a book collection on the History of Medicine. Considerable research was being done in some countries, such as Italy and Finland.

Programs of health education for the public were needed in Italy. For it was noted that "Ignorance of the advantages of medical care and fear of doctors and hospitals are widespread in Italy and deprive many people, particularly children, of the facilities available."

Comparisons of the medical situation in individual countries are difficult because of the varying social and economic conditions, and medical traditions. Two differences were noted. First, medical care was better in Italy than in Greece. Second, medical facilities in Finland were superior to those in Poland. The missions were concerned with medical, not political conditions. However, it should be remembered that the changing political scene may be affecting medical conditions in some countries, such as Czechoslovakia (visited in 1946) and Poland.

These pamphlets are compilations of facts observed by individual physicians. As such they lack organization by subject matter and involve repetition. Apparently some statistics were not carefully checked. However, the pamphlets were not intended to be scientific reports. They do furnish some very interesting information on medical conditions in Europe given by top-ranking medical personnel. The goals and accomplishments of the type of missions described in the pamphlets seem particularly worth while.

ELIZABETH H. JACKSON

INDEX

TO TITLES OF ARTICLES AND AUTHORS IN THE MILBANK MEMORIAL FUND QUARTERLY

VOLUME XXVII • 1949